Palestine Polytechnic University

Tensile Test Machine

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Submitted to the college of Engineering

In partial fulfillment of the requirements for the

Bachelor degree in mechanical engineering

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Palestine Polytechnic University

Collage of Engineering

Mechanical Engineering Department

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Abstract

The project aims at rehabilitate tensile testing machine which is Located in the material laboratory in Palestine polytechnic university (PPU) to work after a long time of stopping because of several damages in the controller and the system، With the addition of a new possibility to the machine which is the tests of tensile and pressure under the influence of temperature ranging from (50° C to 350 ° C).

At the completion of the project, we aim to provide a test machine for the university and for students, are able to perform the tests (tension and compression) in a computerized, high accuracy and ease of use with providing a maximum protection and safety at the level of both the user and the machine.

يهدف المشروع إلى إعادة تأهيل ماكينة اختبار الشد الموجودة في مختبر المواد في جامعة بوليتكنك فلسطين (PPU) للعمل من جديد بعد توقف طويل عن العمل وذلك بسبب أضرار جوهرية على صعيد المتحكم والنظام، مع إضافة إمكانية جديدة للماكينة وهي إجراء اختبارات الشد والضغط تحت تأثير درجة حرارة تتراوح بين (50 درجة مؤوية إلى 350 درجة مؤوية)

ونهدف عند الانتهاء من المشروع إلى توفير ماكينة اختبار للجامعة وللطلاب قادرة على إجراء عمليات الاختبار (الشد والضغط) بصورة محوسبة وبدقة عالية وسهولة الاستخدام مع توفير أقصى درجات الحماية والسلامة على صعيد كل من المستخدم والماكينة.

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Chapter 1

Introduction

This section presents an overview of the tensile testing, its importance and procedures, methods of conducting it and what machines are generally used in the testing process . Also, it particularly talks about the tensile test machine under the effect of heat.

It highlights the faulty machine test at the PPU material testing section and explains why it stopped working and what systems are used before operating the machine, and what ones will be used to run it again. Besides, it presents the project detailed outline, the work methods and stages, the objectives of the project as well as the cost of the project and the expected outputs.

1.1 Background

1.1.1 Tensile Test

There are forces or loads applied on the materials through using it as the steel in an automobile axle. So, we have to do a study to know the characteristics of these materials under different factors like temperature to avoid the deformations or broke that may occur. Besides, there are important mechanical properties (Ex. strength, hardness, ductility, and stiffness).

The mechanical properties depend on a variety of parts that have different interests. Therefore, there must be some harmony in the manners by which tests are conducted.

The tensile test is one of the most common mechanical stress–strain tests. As what will be seen later, there are many important materials mechanical properties that can be ascertained by using the machine tensile testing.

The tensile test is a process that is carried out on a sample with a specific dimension to determine its mechanical properties by applying axial force which starts from zero and gradually increases to the point where the fracture occurs.

The basic idea of the tensile test is to place a sample of a material which has known dimensions, like length and cross-sectional area between two fixtures. Then, we begin to intensify the sample from a side while the other side is fixed. We keep increasing the load on the sample until the length of the sample changes as it is shown in (Figure 1.1).

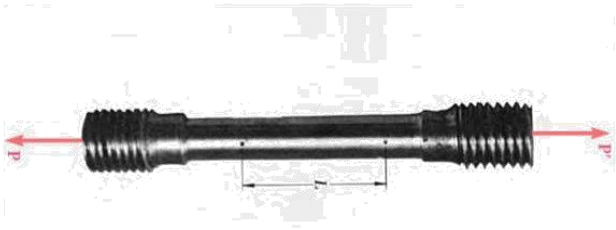


Figure 1.1: Test specimen with tensile load.[1]

1.1.1.1 Stress-Strain Curves

Stress and strain curve is the relationship between stress and motion where the vertical axis is for stress and the horizontal axis is for strain. The curve varies according to the tested materials, which vary in their behavior under the influence of tensile as (Figure 1.2) shows.

A tensile test includes mounting the specimen in a machine, and subjecting it to tension. The tensile force is recorded as a function of the increase in gauge length. (Figure 1.2) shows a typical curve of a ductile material.

The advantage of dealing with stress versus strain rather than load versus elongation is that the stress-strain curve is virtually independent on the specimen dimensions .Through this curve, the following mechanical properties of the tested materials can be determined:

- **Compressive Strength** - The compressive strength is the maximum compressive stress which a material is capable of holding it without any fracture. The fragile materials break during the testing and have a definite compressive strength value. The compressive strength of ductile materials is determined by their degree of distortion during the testing.
- **Elastic Limit** - Elastic limit is the maximum stress that a material can sustain without permanent deformation after the stress removal.
- **Elongation** - Elongation is the amount of permanent extension of a specimen that has been fractured in a tensile test.
- **Modulus of Elasticity** - The modulus of elasticity is the ratio of stress (below the proportional limit) to strain, i.e., the slope of the stress-strain curve. It is considered as the measure of rigidity or stiffness of a metal.
- **Proportional Limit** - The proportional limit is the greatest amount of stress a material is capable of reaching it without deviating from the linear relation of the stress-strain curve, i.e. without developing plastic deformation.
- **Reduction in Area** - The reduction in area is the difference between the original cross-sectional area of a tensile specimen and the smallest area at the first fracture following the test.

- **Strain -** Strain is the amount of change in the size or shape of a material due to the force.
- **Yield Point -** The yield point is the stress in a material (usually less than the maximum attainable stress) at which there is an increase in strain occurs without an increase in stress. Only certain metals have a yield point.
- **Yield Strength -** The yield strength is the stress at which a material exhibits a specified deviation from a linear stress-strain relationship. An offset of 0.2% is often used for metals.
- **Ultimate Tensile Strength -** Ultimate tensile strength, or UTS, is the maximum tensile stress a material can sustain without fracture. It is calculated by dividing the maximum load applied during the tensile test by the original cross sectional area of the sample.

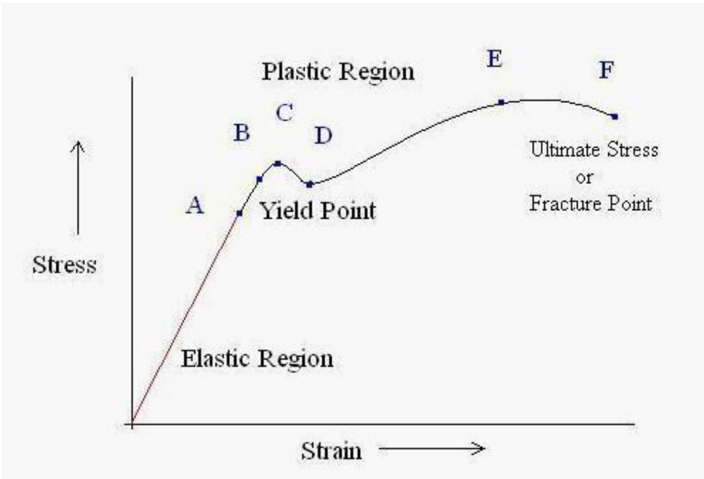


Figure 1.2: Stress-strain diagram.

Engineering stress, or nominal stress" σ " is defined as:

$$\sigma = \frac{F}{A\,o} \qquad (1.1)$$

Where "F" is the tensile force and "Ao " is the initial cross-sectional area of the gage section.

Nominal strain is defined as:

$$\varepsilon = \frac{\Delta L}{Lo} = \frac{L - Lo}{Lo} \qquad (1.2)$$

Where L_0 is the initial gage length and "ΔL" is the change in gage length (L- L_0).

When a small stress is applied on a solid material, the bonds between the atoms will be stretched. When the stress is removed, the bonds relax and the material returns to its original shape. This temporary deformation is called elastic deformation, as shown in figure (1.3).

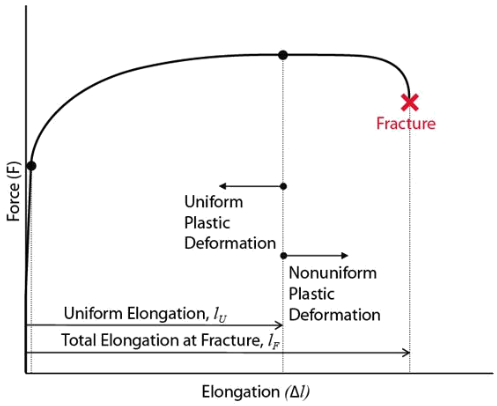


Figure 1.3: Elastic versus plastic deformation.

At higher stresses, levels of atoms slide over one another. This deformation, which is not recovered when the stress is removed, is called plastic deformation. Bending a wire (such as paper-clip wire) illustrates the difference (Figure 1.4). If the wire is bent a little bit, it will snap back after releasing (top). With larger bends, it will unbend elastically to some extent in releasing, but there will be a permanent bend because of the plastic deformation (bottom) [2].

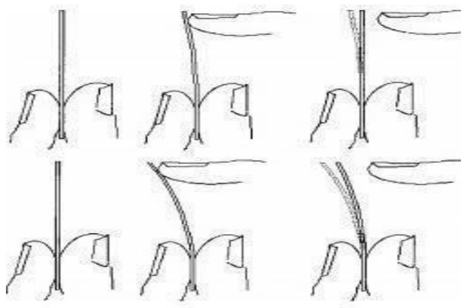


Figure 1.4: Elastic and plastic deformation of a wire with the fingers.

For most materials, the initial portion of the curve is linear. The slope of this linear region is called the elastic modulus or Young‟s modulus:

$$E = \frac{\sigma}{\varepsilon} \qquad (1.3)$$

In the elastic range, the ratio „υ‟ of the magnitude of the lateral contraction strain to the axial strain is called Poisson‟s ratio:

$$\upsilon = -\frac{\varepsilon_x}{\varepsilon_y} \qquad (1.4)$$

(In an x-direction tensile test)

1.1.1.2 Yield point

The point at which a solid material that is being stretched begins to flow or change its shape permanently divided by its original cross-sectional area or the amount of stress in a solid at the onset of permanent deformation. The yield point, alternatively called the elastic limit, marks the end of an elastic manner and the beginning of a plastic. When stress in the yield point is removed, the material returns to its original shape. A few materials start to yield or flow plastically, at a fairly well-defined stress (upper yield point) that falls rapidly to a lower steady value (lower yield point) as deformation continues. Any increase in the stress beyond the yield point causes greater permanent deformation and eventually fracture.

For steels, the subsequent lower yield strength is used to describe yielding. This is because the measurements of the initial maximum or upper yield strength are extremely sensitive to how axially the load is applied during the tensile test. Some laboratories cite the minimum, whereas others cite a mean stress during this discontinuous yielding. [2]

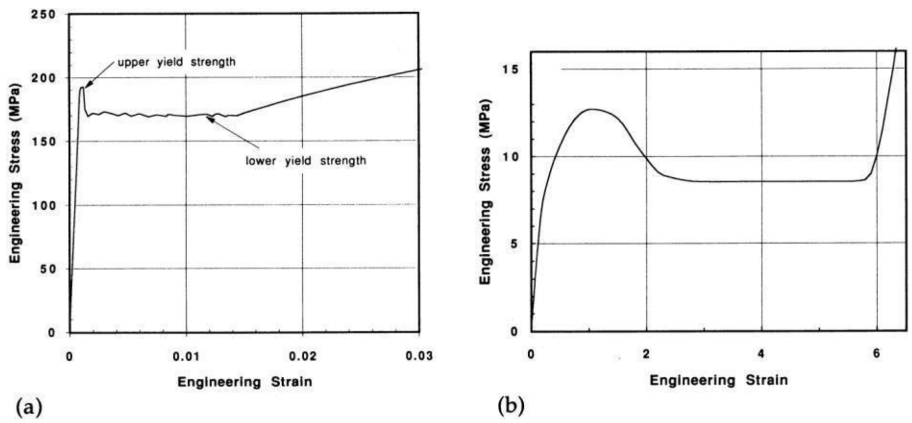


Figure 1.5: Inhomogeneous yielding of low-carbon steel (a) and a linear polymer (b). After the initial stress maxima, the deformation occurs within a narrow band, which propagates along the entire length of the gage section before the stress rises again.

The tensile strength (ultimate strength) is defined as the highest value of engineering stress (Figure 1.5). Up to the maximum load, the deformation should be united along the gage section. For the ductile materials, the tensile strength correspond the point at which the deformation starts to localize and thus forms a neck (Figure 1.6a). Few ductile materials fracture before they neck (Figure 1.6b). In this case, the fracture strength is the tensile strength. Indeed, very brittle materials (e.g., glass at room temperature) do not yield before fracturing (Figure 1.6c). Such materials have tensile strengths not yield strengths.[2]

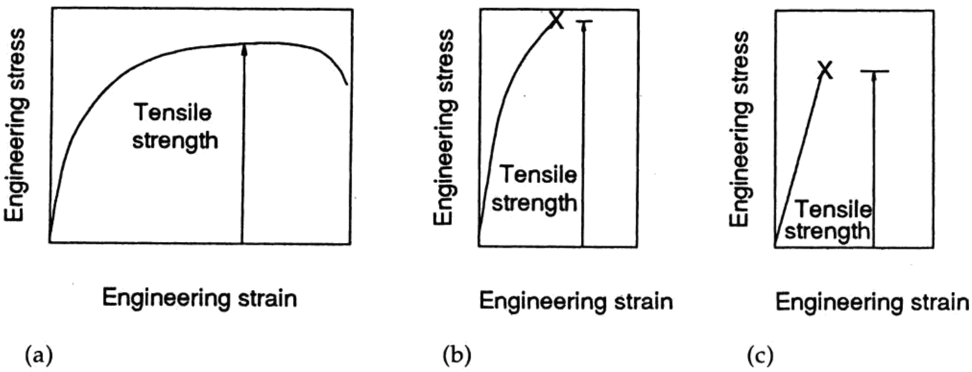


Figure 1.6 : Stress-strain curves showing that the tensile strength is the maximum engineering stress regardless of whether the specimen necks (a) or fractures before necking (b and c).

1.1.2 Compression Test

The Compression test is the opposite of the tensile test where the applied force is in the opposite direction than in the tensile test as (Figure 1.7) shows.

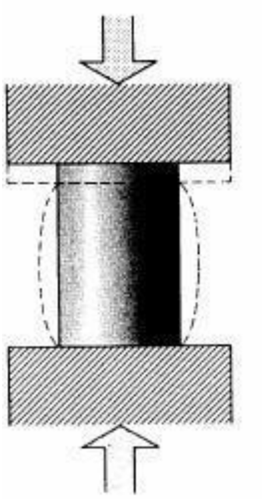


Figure 1.7 : direction of force in Compression Test

A compression test is a method of determining the conducts of the different materials under a compressive load. Compression tests are conducted by loading the test specimen between two plates, and then applying a force to the specimen by moving the crossheads together. During the test, the specimen is compressed, and the deformation versus in the applied load is recorded. The compression test is used to determine:

- elastic limit
- proportional limit
- yield point
- yield strength
- Compressive strength.

$$\sigma = \frac{F}{A\,o} \qquad (1.5)$$

$$e = \frac{\Delta L}{Lo} \qquad (1.6)$$

Compression testing is the basis of accepting the non-metallic materials such as concrete, stone, wood and others and it is not commonly used to test metals for many reasons.

1.1.3 Tensile Test with temperature effect:

We need to test the tensile under the influence of different temperatures to match the reality of the occurrence that affect different applications. Materials may be presented in applications that impose such an effect as industrial furnaces, friction sites, or in difficult environmental sites such as desert, etc.

Usually, after installing the test piece in its position on the tensile testing machine, a thermal source of energy is then applied to the test piece, and when the temperature of the test reaches the required point, the tensile test shall be applied.

The Tensile properties depend on the temperature. Yield strength, tensile strength, and modulus of elasticity decrease at higher temperatures, whereas ductility commonly increases. A materials fabricator may deform a material at a high temperature (hot working) to take advantage of the higher ductility and lower required stress.

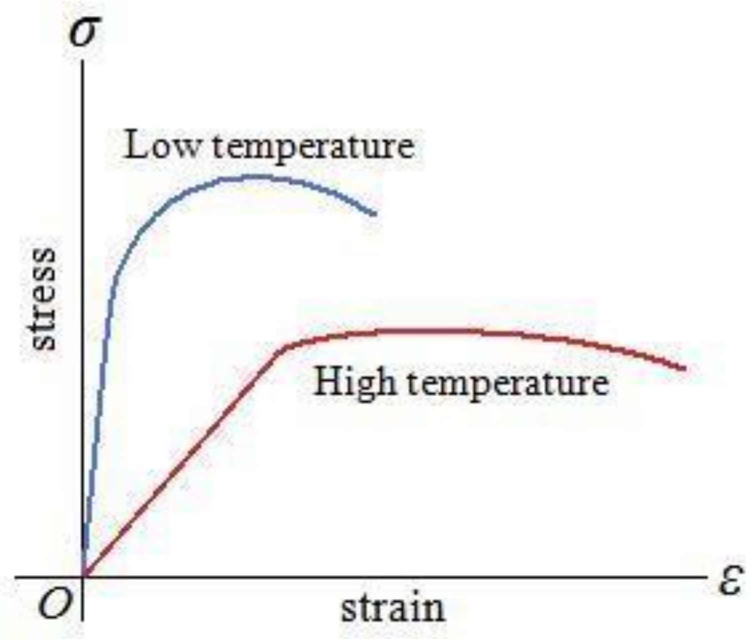


Figure 1.8 : Stress-strain diagram showing relationship between low temperature and high temperature

In the steady-state tests, the test specimen was heated up to a certain temperature. Then, a tensile test was carried out. In the steady state tests, stress and strain values were first recorded and from the stress-strain curves which the mechanical material properties could be determined. The steady state tests can be carried out either as strain or load controlled. In the strain-controlled tests, the strain rate is kept constant and in the load-controlled tests the loading rate is kept constant. [3]

In transient-state tests, the test specimen is under a constant load and temperature rise. Temperature and strain are measured during the test. As a result, a temperature-strain curve is recorded during the test. Thermal elongation is subtracted from the total strain. The results are then converted into stress-strain curves as shown in (Figure 1.9). [3]

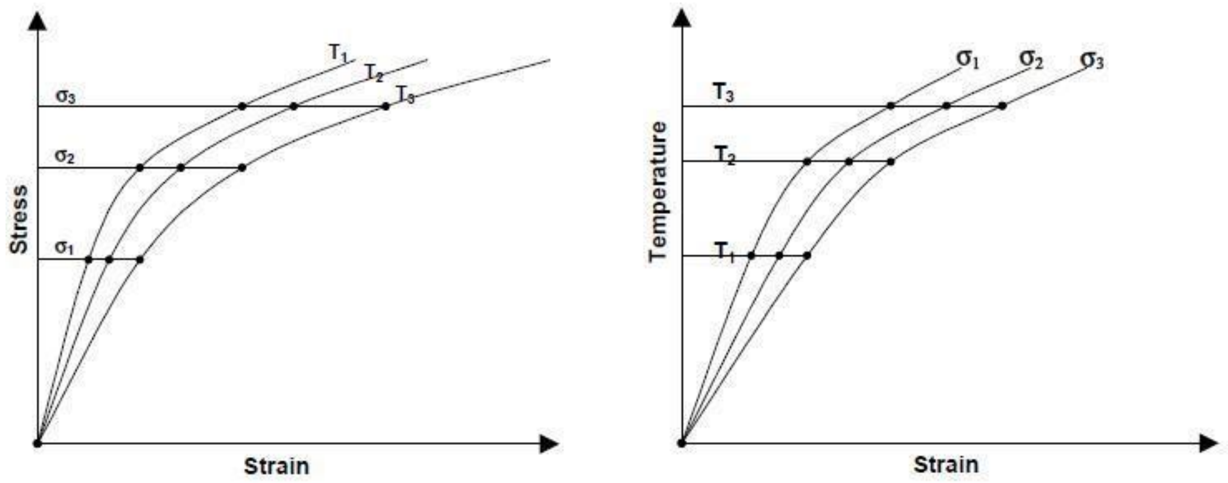


Figure 1.9 : Converting the stress-strain curves from the transient state test results**.**

1.2 Problem Definition

The project focused on the reform of an existing tensile test machine in the laboratory of materials, as the machine has been out of work since a long period for the following reasons.

1. Damage of the main controller.
2. Damage of the machine operational program
3. Damage of the main measuring sensor.
4. Harm in the connecting wires.
5. The expensive cost of maintenance the machine.
6. Tests are performed manually.
7. Tests can only be done in a certain room temperature.
8. The machine lacks many of the elements of protection, the test piece, and parts of the machine.
9. The methods of storing data in the system are very traditional (through paper publications).

Figure 1.10: Hydraulic Tensile Test Machine project.

1.3 Project Objectives:

1. Replace the main control to the computer and DAQ.
2. Construct an operational program and distinct user interface that is easy to be used.
3. Change the main sensor and set into a good sensor with a high accuracy.
4. Change the connecting wires.
5. Reduce the operational maintenance costs of the machine.
6. Doing the test without any interference by the user.
7. Perform all the tests under the room temperature (approximately 25 Celsius).
8. Raise the level of the protection of the parts of the machine and the user as well as the test piece.
9. Store data in a computerized system.

1.4 State of the art:

After looking at similar tensile test machines, there are many industries that produce such machines. For example, Bent tram A/S, Physical Test Solutions (PTS) and Euro dip HLCR, but the cost of these machines is so expensive. The table below shows the difference between some of these machine and ours.

Table 1.1: Tensile Test Machines Comparison**.**

Comparison	FMCC-50[4]	UCT[4] Electrical	HLCR-300[4]	This Proposed Machine
Actuator Type	Motor plus a rack-pinion	Motor plus a rack-pinion	Hydraulic Piston	Hydraulic Piston
Load capacity	50 KN	20 KN	300 KN	43 KN
Stress sensor	Load cell	Load cell	Load cell	Pressure sensor
Displacement Sensor	Extensometer	Extensometer	Photoelectric Encoder	Photoelectric Encoder
Displacement Relaxation	0.001 mm	0.12 mm	0.001 mm	0.001 mm
Price	$ 31,000	$ 25,000	$ 43,000	$ 9,000
Picture				

1.5 Conceptual design:

Is an early phase of the design process, in which the broad outlines of function and form of something are articulated, it includes the design of interactions, experiences, processes and strategies. It involves an understanding of people's needs - and how to meet them with products, services, & processes. Common artifacts of conceptual design are concept sketches and models. And the following sketch

In this design, each of unit from all of the system units has specific symbol as follow:

1. E: Electrical system.
2. H: Hydraulic system.
3. A: Alarm system.
4. T: Temperature system.
5. D: Data system.
6. MD: System of deflection measurement.

(Hint: The attached figure (1.11) explains the conceptual design of the project fully).

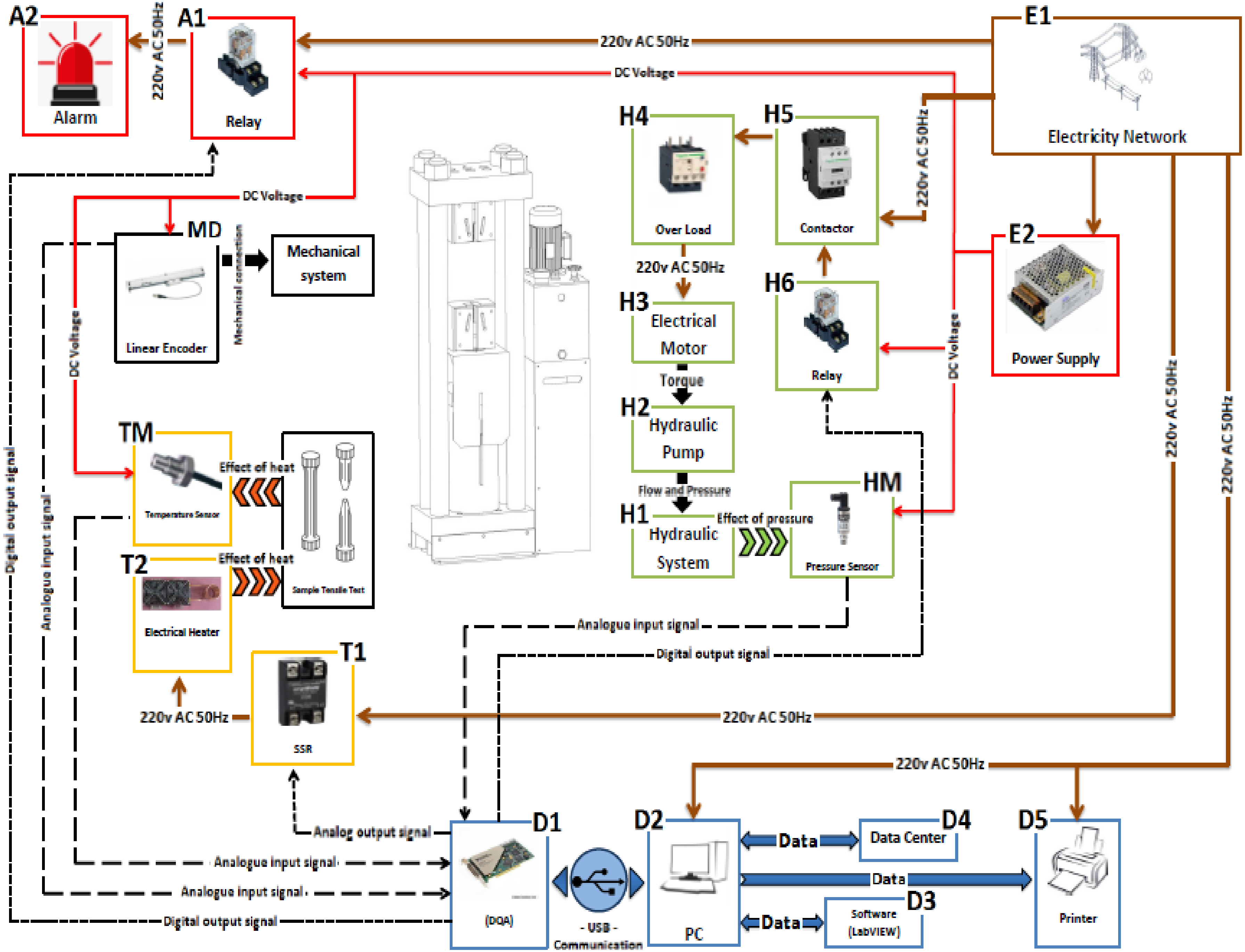


Figure 1.11: conceptual design.

The general system consists of a set of subsystems formed by a group of allocated system separately elements as shown in (Figure 1.11) and each system has a function that distinguishes it from other systems but there is coherence and integration between all of these systems to achieve the overall objective of the project and these systems are :

1.5.1 Electrical system (E):

The system is powered by an electrical network (E1) with a voltage of (220v AC 50Hz) but we use a power supply (E2) which converts the voltage (220v AC 50Hz) to the direct voltage (24v DC) to power some elements of the system that work with a direct effort (24v DC) such as pressure sensor (HM) and deflector sensor (MM) and others.

1.5.2 Control system and data processing (D):

The DAQ (D2) device reads physical signals from sensors working on pressure measurement, deviation measurement, temperature measurement and others. The DAQ (D2) converts these physical values (voltage signal) into digital values (0-1 signal) and the computer can read it and process it through a software called LABVIEW (D3) .The conversion process results in a set of orders and instructions which are transferred by the computer to the device DAQ (D2) to be re-converted again from digital values to voltage values that the system responds to.

1.5.3 System of deflection measurement (MD):

The deflection of the test piece is measured by a measurement sensor called a linear encoder (MD) which helps to measure the deflection up to 0.005mm.

1.5.4 Thermal system (T):

This part is one of the most important additions to the project. We can hold tensile test under the effect of heat in a room temperature of 350^{o} and the test piece is heated by electric heaters (T2) controlled by solid state relay (SSR) (T1). SSR is an electronic component that changes the output voltage based on input voltage values which is obtained through the controller DAQ (D2). Temperature sensor works on measuring the temperature of the test piece and it represents a feedback signal to the system.

1.5.5 Hydraulic system (H):

The electric motor (H3) generates a torque capable of managing the hydraulic pump (H2) which in turn is based on generating oil pressure in the hydraulic system (H1) and Electric feeding (220v AC 50Hz) to the electrical motor which is controlled by the Contactor (H5) through the electrical protection elements over load (H4) and the contactor gets an electrical control signal (24v DC) through a relay (H6) which acts as an intermediary between the controller DAQ (D2) and the contactor (H5). Pressure is measured in the system by the pressure sensor (HM) which converts the physical signal into an electrical signal (0-5v DC) and this is a feedback signal for the system.

1.5.6 Alarm system (A):

When a defect occurs in the different systems, the controller works DAQ (D2) to notify the system alarm through a digital signal for the relay (A1). It works to connect the electrical signal (24v DC) to the alarm lamp (A2).

1.6 Time plan

Table 1.2: Time table for the second semester time (week)

Week numb / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Selecting the group team and the supervisor	■															
Choosing the project		■														
Studying the project In general			■													
Writing an initial report				■												
Making a Detailed study that doesn't exceeds the details of the company.					■	■										
Examining the mechanical system and structure, discussing the solutions and formally demonstrating the machine using a design program							■									
Selecting the controller and the electrical elements								■								
Simulating the project									■	■						
Writing the introduction of the project											■	■				
Making the final adjustments to the intro according to the supervisor's suggestions													■			
Submission of the project introduction														■		
Making the final preparations															■	
The discussion																■

1.7 Cost Estimation

Table 1.3: The initial cost estimation table for the components used in the project

Numb	Components	The Description	Quantity	Estimated Price Of Components(JD)	Total Price(JD)
1	Computer	Laptop	1	100	100
2	Analog to digital (DAQ)	DAQ Usp-6008	1	400	400
3	Pressure Sensor	Input : 24v Dc Output : 0-5v Dc Max Pressure 700 Bar	1	350	350
4	Linear Encoder	Input : 24v Dc Output : Pulse Signal 5v Dc Relaxation : 0.005mm Length : 60cm	1	500	500
5	Power Supply	Input : 220v 50hz Output : 24v Dc 5a	1	20	20
6	Contactor	Coil : 24v Dc 2.2 Kw	1	20	20
7	Relay	Coil : 5v Dc	2	10	20
8	Over Load	-	1	20	20
9	Electrical Heater	-	1	100	100
10	Temperature Sensor	-	1	30	30
11	SSR	Input : 0-5v Dc Output : 220v Dc 60a	1	20	20
12	Alarm	220v 50hz	1	20	20
13	Other Expenses	-	-	200	200
				Total Price	1800

2

Chapter 2

Electrical Design

This chapter talks about all the electrical components in the machine and the integration of these components, which include: the data acquisition card (DAQ) , the software control DAQ, the electro-hydraulic part , heaters, sensors , the linear displacement sensors , the pressure sensor as well as the thermocouple sensor.

2.1 Electrical Connection

(Figure 2.1) shows the Control circuit in a temperature Tensile Test Machine, and how the connection between all the electrical component is .

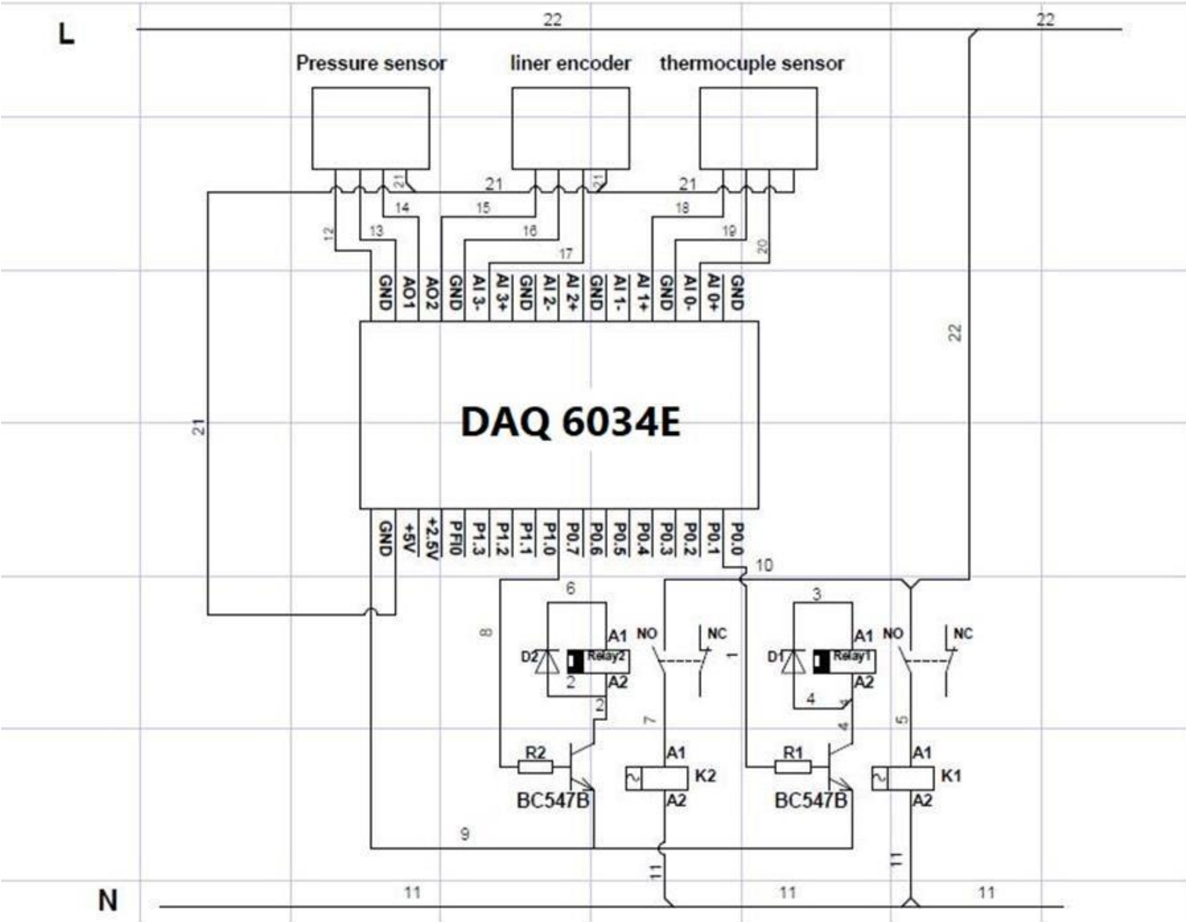


Figure 2.1: Electrical Control circuit for a Tensile Test Machine**.**

From this Control circuit, we can control the operation of the hydraulic pump from the first contactor and the heaters from the second contactor where they are connected by a relay from 5v to 220 by the DAQ which is connected to the computer then we take the readings from the sensors to the controller and then it appears on the computer.

The Electrical Connections in (Figure 2.2) shows the power circuit.

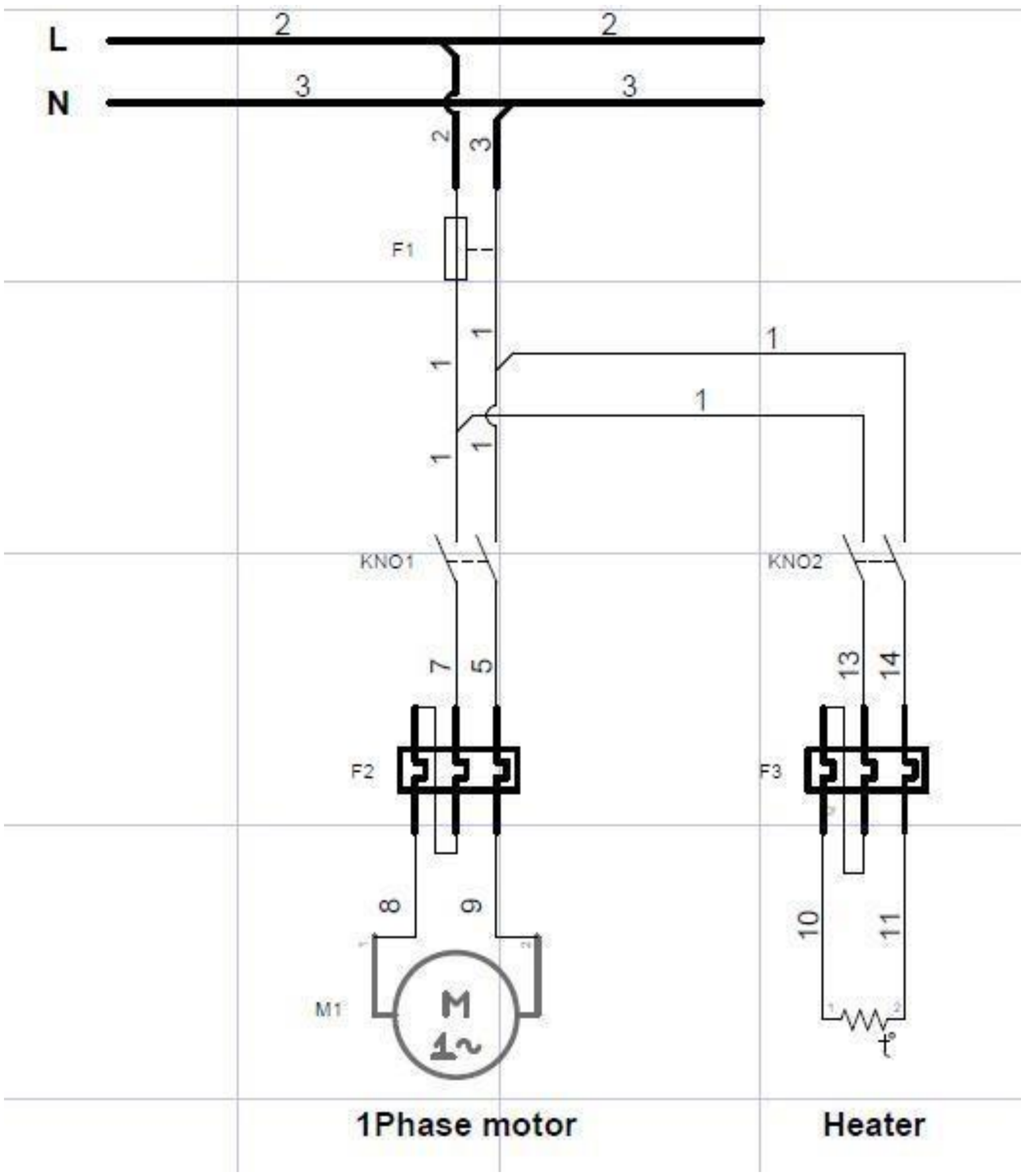


Figure 2.2: The Power Circuit.

2.2 Hydraulic system

The controlled movement of the parts or the controlled application of the force of a tensile on a Metal is the most important part of the tensile testing machine. In this process, we use the hydraulic system.

(Figure 2.3) shows the hydraulic control for a Computerized Hydraulic Tensile Test Machine which includes the double acting cylinder (piston), the pressure sensor and the relief valve.

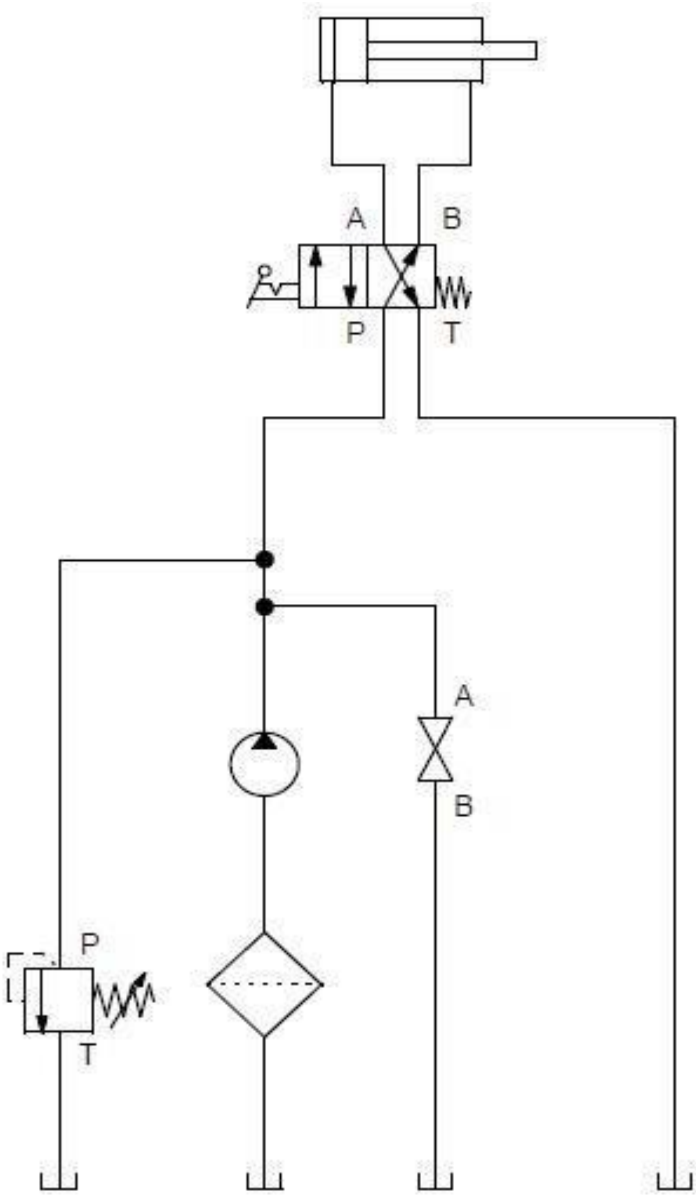


Figure 2.3: Hydraulic circuit.

2.3 Data acquisition system

A DAQ acts as the interface between the computer and the outside world. It primarily functions as a device that digitizes the incoming analog signals so that the computer can interpret them. Data acquisition involves gathering signals from the measurement sources and digitizing the signal for storing it, analyzing it, and presenting it on a PC. [5]

- **The components of data acquisition systems include:[5]**

1. Sensors that convert the physical parameters to electrical signals.
2. Signal conditioning circuitry to convert the sensor signals into a form that can be converted to digital values.
3. Analog-to-digital converters which convert the conditioned sensor signals to digital values.

- **A DAQ usually has these functions show (Figure 2.4): [6]**

1. Analog I/O
2. Digital I/O
3. Counter/timers
4. Sensors

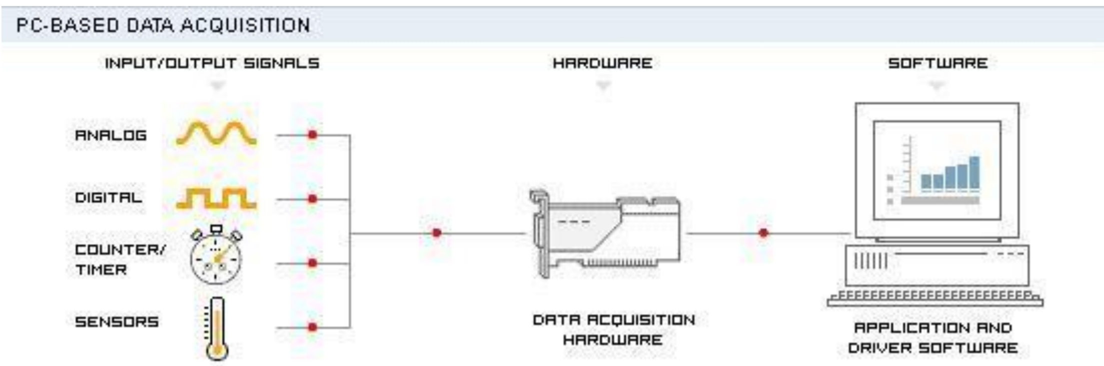


Figure 2.4 : functions of DAQ[3].

- **Physical input/output signals**

A physical input/output signal is typically a voltage or current signal. A voltage signal can typically be a 0-5V signal, while a current signal can typically be a 4-20mA signal.[5]

2.3.1 DAQ Hardware

DAQ hardware is what usually interfaces between the signal and a PC . We will use NI USB DAQ-6034E in our Project.

NI USB DAQ-6034E

NI USB DAQ-6008 that is shown in (Figure 2.5) is a simple and low-cost multifunction I/O device from National Instruments, and (Figure 2.6) Explains the dimensions of DAQ in inches and mm.[5]

Figure 2.5: A/D (DAQ) national instruments usb-6034E[5]

Figure 2.6: NI USB-6034E connecting port in Millimeters (Inches)**.**

- **The device has the following specifications:[6]**

1. 8 analog inputs (12-bit, 10 kS/s)
2. 2 analog outputs (12-bit, 150 S/s)
3. 12 digital I/O
4. USB connection, No extra power-supply needed
5. Compatible with Lab VIEW, Lab Windows/CVI, and Measurement Studio for the Visual Studio .NET.
6. NI-DAQ mx driver software

- **Why we chose this controller:**

1. It uses a port which enables us to connect it to any computer or tablet
2. Its price is relatively cheap
3. It Achieves the required target to operate the machine
4. Its speed is suitable for the machine.

2.3.2 DAQ Software

DAQ software is needed for the DAQ hardware to work with a PC. The program is a lab view.

- **Lab view code:**

LabVIEW (an abbreviation for Laboratory Virtual Instrumentation Engineering Workbench) is a platform and a development environment for a visual programming language from the National Instruments. The LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows, various flavors of UNIX, Linux, and Mac OS X. [5]

- **Each VI contains three main parts:**

1. Front Panel: How the user interacts with the VI.
2. Block Diagram: The code that controls the program.
3. Icon/Connector: Means of connecting a VI to other vis.

2.4 Induction Heaters

Induction heaters are used to convert the Electrical power to a thermal power in a system. Also, we use heaters in a tensile test for testing the material under a temperature effect. We will use the Cartridge Heaters that is shown in (Figure 2.7).

- **Features of this heater**

1. The possibility to be installed appropriately.
2. Temperatures up to 800°C
3. low price

Figure 2.7: Induction heating unit [8]

2.5 sensors

In our project, will we use 3 types of sensors as shown here:

1. The pressure sensor.
2. The linear displacement encoder.
3. The thermocouple sensor.

2.5.1 Pressure sensor

The pressure sensor that is used in this project is: M5200 industrial pressure transformer. it Measures the force of the oil pressure when there is an effect on the hydraulic cylinder and it can read the load capacity of almost 700 bar (10 Kpsi) which represents the maximum pressure for a machine. (Figure 2.8) shows the Construction of Pressure Sensors.

- **Fetuses:**[7]

1. Heavy Industrial CE Approval
2. 10 V/m EMI Protection
3. Reverse Polarity Protection on Input
4. Short Circuit Protection on Output
5. ±0.25% Accuracy
6. ±1.0% Total Error Band
7. Compact Outline
8. -40°C to +125°C Operating Temperature
9. Weatherproof

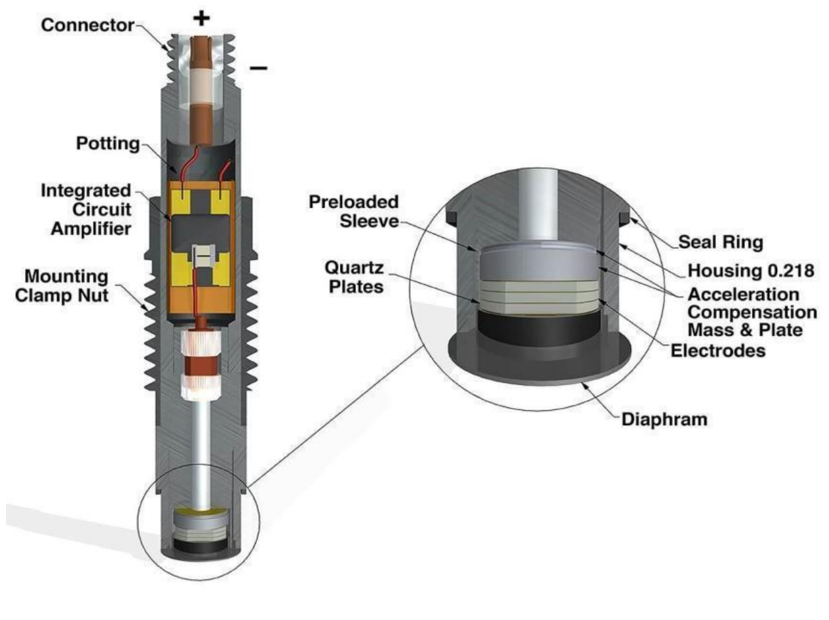


Figure 2.8: Typical quartz pressure sensor cross section [7].

2.5.2 Linear displacement encoder

To determine the elongation of the test piece during the tensile operation, we will use liner encoder, shown in (Figure 2.9), and has a resolution of 1micro-meter and gets the signal as digital readout (digital pulses). The linear encoder is fixed to the lower moveable part and it is enable to measure the deflection that occurred in the piece along the stroke.

- **Fetuses:[11]**

1. 5 um resolution
2. Precision engineered Infrared sensor
3. 5 ball bearings supporting system
4. Dual seals IP53 protection
5. Armored cable
6. High noise immunity
7. 5V operation
8. Quadrature digital output
9. The gage length is 60 cm.

Figure 2.9: Linear Encoder [9]

2.5.3 Thermocouple

A Thermocouple is a sensor used to measure the temperature, there are many types of thermocouples each with its own unique characteristics in terms of temperature range, durability, vibration resistance, chemical resistance, and application compatibility.[9]

There are many types of thermocouple commonly used as J, K, T, & E. We will use the K Thermocouple which is the most common type of thermocouple. It‵‵s inexpensive, accurate, reliable, and has a wide temperature range.

- **Accuracy :**

1. Standard: +/- 2.2C or +/- .75%
2. Special Limits of Error: +/- 1.1C or 0.4%

3

Chapter 3

Mechanical System

In this section, we will present many details about the mechanical system and its various parts as well as discuss the static analysis of the Hydraulic Tensile Test Machine, which includes the machine model, the static analysis of the mechanical structure, and the static analysis of the specimen.

3.1 Mechanical system:

The mechanical system consists of three separated sections, each of them is with a specific function distinct from the others, but these sections are interrelated to form the general system of the machine. Those sections are:

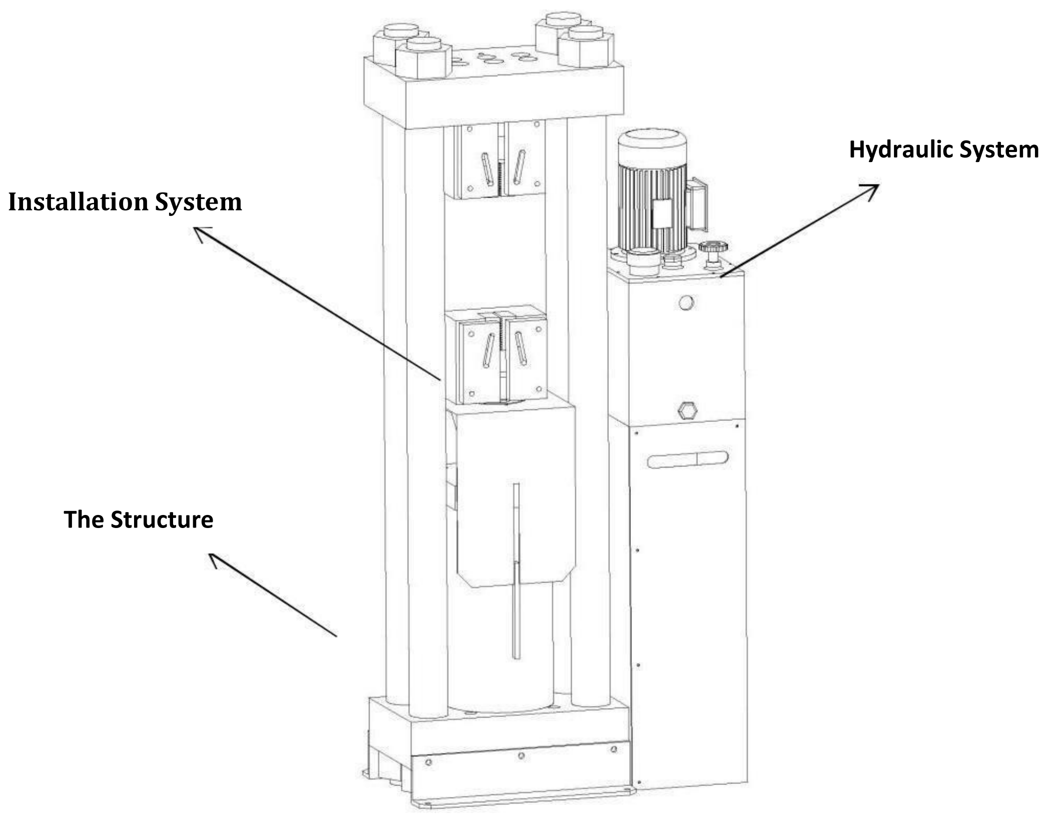
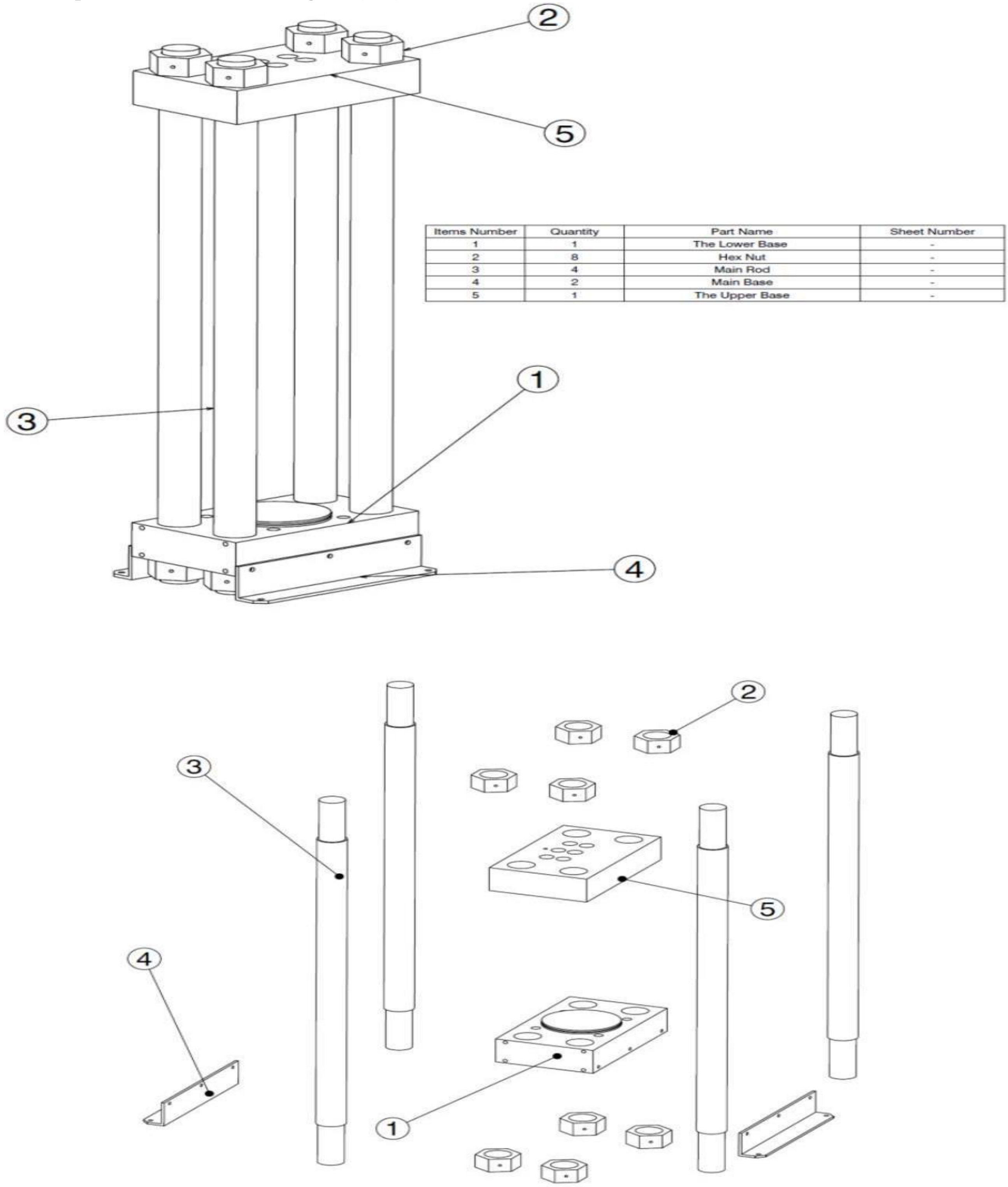


Figure 3.1: Sections of the mechanical system.

3.1.1 The mechanical structure:

It is the main section of the mechanical system which gives the overall shape of the machine and all of the other parts are installed on it. The structure consists of several main parts as shown in the figure (3.2):



Items Number	Quantity	Part Name	Sheet Number
1	1	The Lower Base	-
2	8	Hex Nut	-
3	4	Main Rod	-
4	2	Main Base	-
5	1	The Upper Base	-

Figure 3.2: Elements of the structure**.**

Figure 3.2 shows the parts of the mechanical structure which are :

1. **The Lower Base:**

(Figure 3.2) shows The Lower Base whose function is to install the main columns which is , at the same time , the base of the piston .

2. **Hex Nut (2):**

There are eight nuts in the system four of them are to install the upper base and the others are to install the lower base.

3. **Design check versus temperature:**

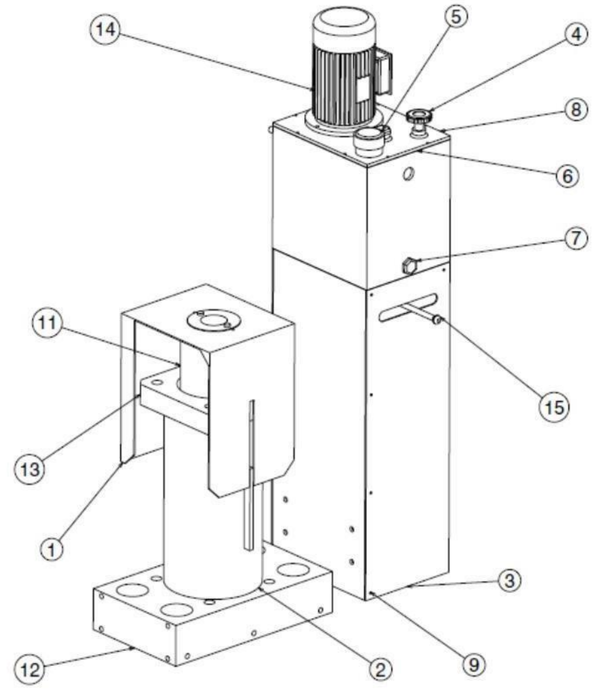
The function of these rods is to install the lower and upper base and withstand the force resulting from the tensile and compression operations.

4. **The Upper base :**

It is similar to The Lower Base as shown in (Figure 3.2). It has the same function of fixing the main rod with extra function to install The Upper Grip.

3.1.2 Hydraulic system:

It is the system source of power through which the pressure and tensile operations are controlled and the hydraulic system consists of a set of elements which are:



Item Num	Quantity	Part Name	Cheet Number
1	1	Cover of Cylinder	sheet 2/1
2	1	Cylinder	sheet 2/2
3	1	Hydraulic system cover	sheet 2/3
4	1	Flow Valve	sheet 2/4
5	1	Flow Control Valve	sheet 2/5
6	1	Oil Container	sheet 2/6
7	2	Sealant	sheet 2/7
8	1	The container cover	sheet 2/8
9	1	Container Base	sheet 2/9
10	1	Piston	sheet 2/10
11	1	Piston Rod	sheet 2/11
12	1	The Lower Base	sheet 2/12
13	1	The upper base of the piston	sheet 2/13
14	1	Motor	sheet 2/14
15	1	Directional control valves	sheet 2/15

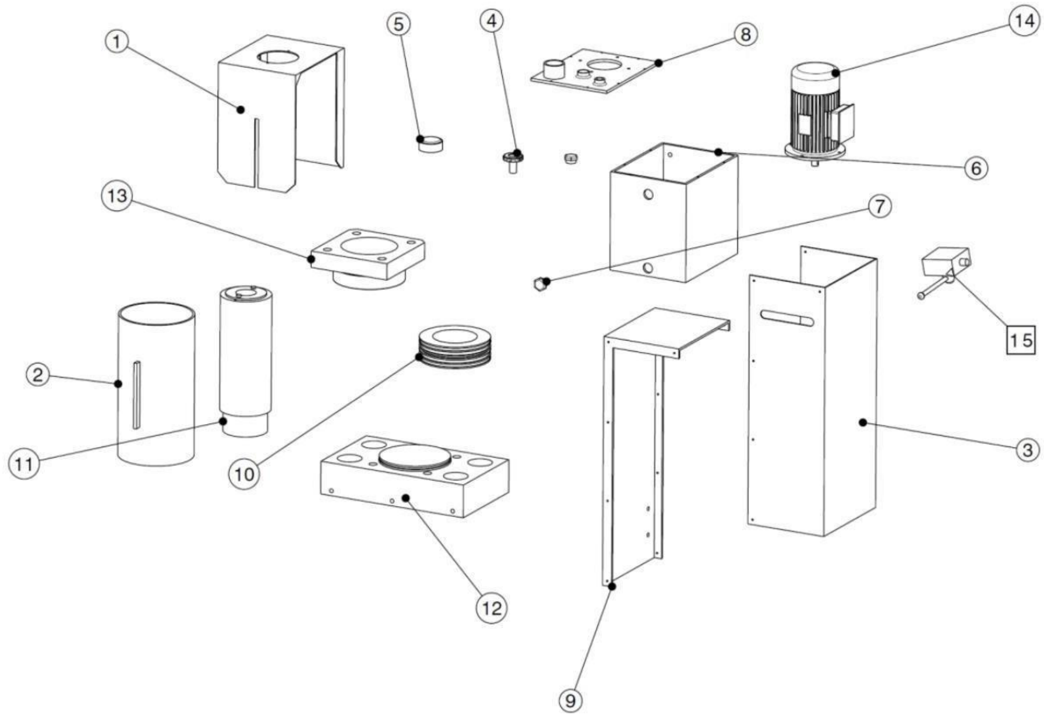


Figure 3.3: The hydraulic system elements.

Figure 3.3 shows the parts of the hydraulic system which are as follows:

6. Oil container:

It is a rectangular vessel that contains the Oil which is used in the hydraulic system and it carries the rest of the hydraulic system components such as the engine and the pump and controls the switch and other parts (Figure 3.3).

11. Hydraulic piston:

As we have said before, the hydraulic system is the source of power in the system and this force is the movement of the piston and pressure in both tensions. The following figure (Figure 3.4) illustrates the different parts of the hydraulic piston.

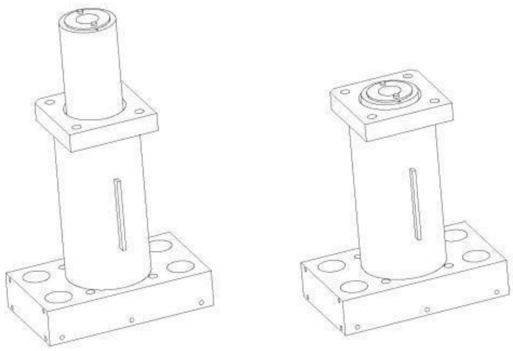


Figure 3.4: Hydraulic piston.

14. Electrical motor:

The engine transforms the electric energy into kinetic energy which in turn moves the pump shaft to generate pressure:

Table 3.1: Nominal plate of an electric motor

Numb	Description	
1	The Manufacture Company	LAFERT
2	Type	LMT 80L4
3	Power	0.75kw
4	Phase	1~
5	Volt	230v
6	Frequency	50Hz
7	Current	5.4A
8	Speed	1435rpm
9	CB	25µF/400v
10	Cosφ	0.91

5. Directional Control Valves (DCV) :

The main function of the Directional Control Valves (DCV) is to control the movement of the piston down (tensile) and up (compression) .The type of the test is chosen manually by using a stick that determines the direction of the oil flow movement. This type is shown in (Figure 3.5)

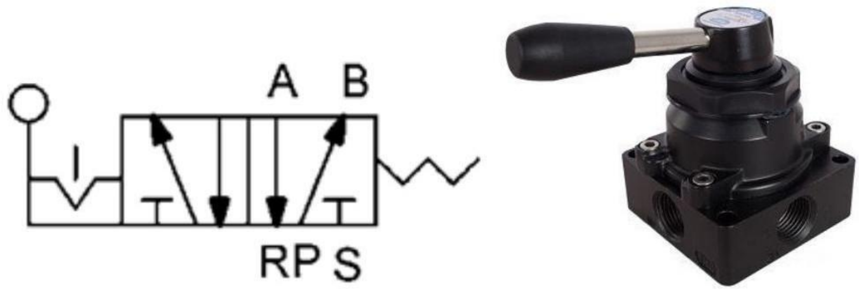


Figure 3.5: Directional Control Valves (DCV).

- **Oil pump :**

These pump work to pump the oil from the container to the different parts of the mechanical system and the pump which is used in the system is the piston type which is characterized by generating very high pressures. (Figure 3.6) shows these pumps.

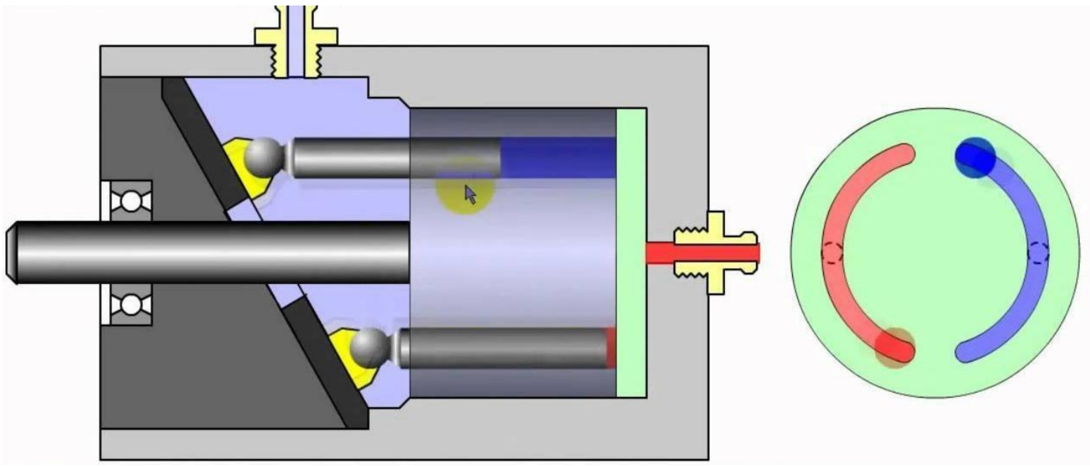


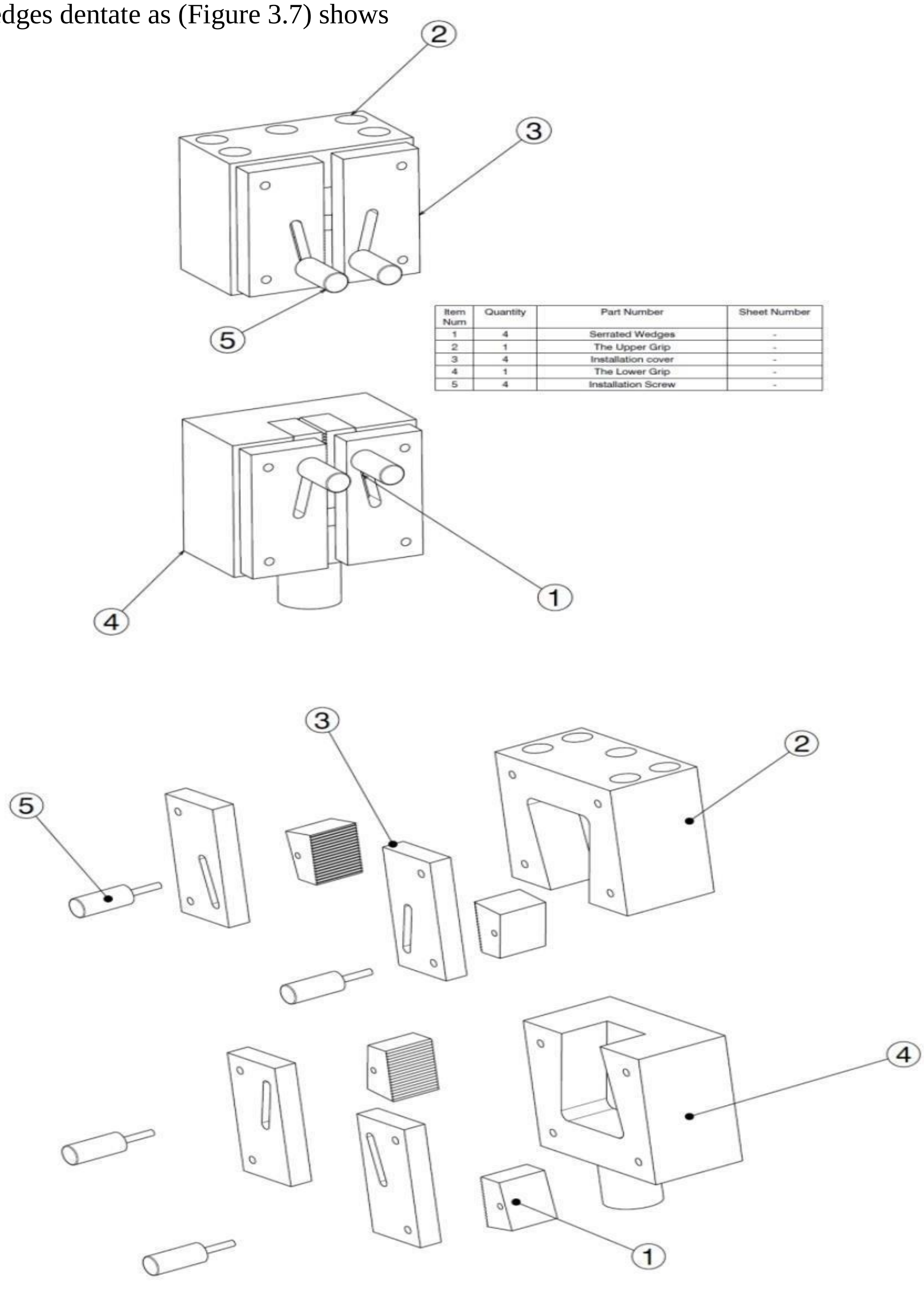
Figure 3.6: Piston oil pump .

3.1.3 System of sample test installation:

There are special tools to install the test sample for both of the tensile test and the compression test and we will explain them:

3.1.3.1 Tensile test:

The method that is used to install the test sample in the tensile test in this machine is the wedges dentate as (Figure 3.7) shows



Item Num	Quantity	Part Number	Sheet Number
1	4	Serrated Wedges	-
2	1	The Upper Grip	-
3	4	Installation cover	-
4	1	The Lower Grip	-
5	4	Installation Screw	-

Figure 3.7: System of test sample installation in tensile test (wedges dentate).

3.1.3.2 Compression test:

The method that is used to install the test sample in the Compression test is a set of cylinder placed on the top of each other as (Figure 3.8) shows

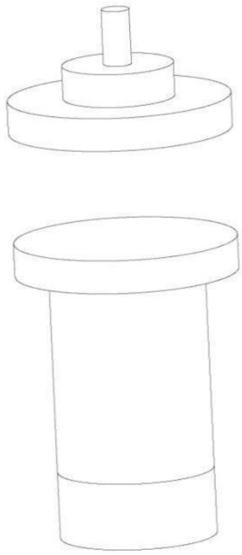


Figure 3.8: System of test sample installation in Compression test (cylinders).

3.2 Static analysis for hydraulic tensile test machine:

3.2.1 Hydraulic Piston:

3.2.1.1 Compression Mode:

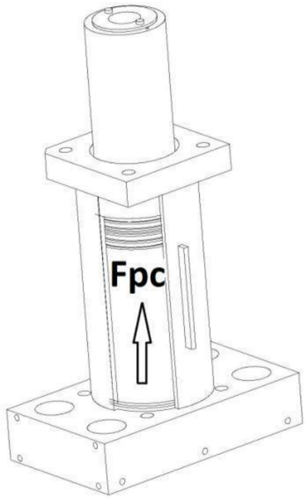


Figure 3.9: The direction of the piston force in Compression mode.

The piston force: $$F_p = P * A \qquad (3.1)$$

- A: area of piston.
- F_p: piston force.
- P: oil pressure.

In the compression mode: $$F_{pc} = P * A_{pc} \qquad (3.2)$$

- A_{pc}: The area of piston in the compression mode.
- F_{pc}: the piston force in the compression mode.

$$A_{pc} = \frac{\pi}{4} d^2 \qquad (3.3)$$

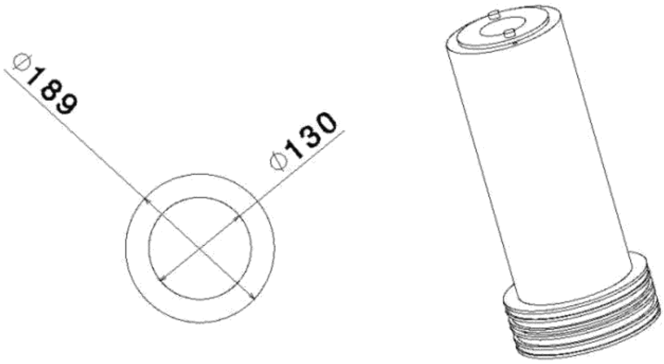


Figure 3.10: Area of the piston section and rod section **.**

$$A_{pc} = \frac{\pi}{4} d^2 = \frac{\pi}{4} (200 * 10^{-3})^2 = 0.0314 m^2$$

$$F_{pc} = P * A_{pc} = 589.69*100*10^3 *0.0314 = 1,879,886.6N = 1.8\ MN$$

3.2.1.2 Tensile Mode:

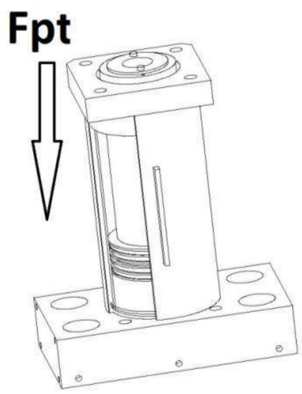


Figure 3.11: the direction of the piston force in tensile mode

$$F_{PT} = P * A_{pt} \qquad (3.4)$$

- A_{PT}: area of piston in the tensile mode.
- F_{PT}: the force of piston in the tensile mode.

$$A_{pt} = \frac{\pi}{4} (d_2^2 - d_1^2) = \frac{\pi}{4} \{(200 * 10^{-3})^2 - (130 * 10^{-3})^2\} = 0.0181335 m^2$$

$$F_{PT} = P * A_{PT} = 589.69*100*10^3 *0.0181335 = 1,069,314.36N = 1\ MN$$

3.2.2 The mechanical structure:

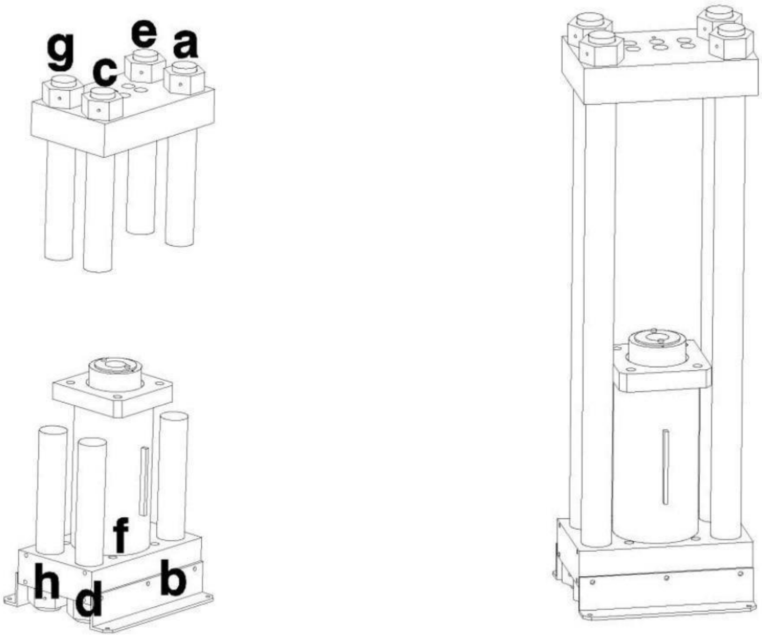


Figure 3.12: Distribution of links

Table 3.2: Dimensions for the parts of mechanical model structure.

numb	Part name	Part length (m)	Cross sectional dimensions(m)	Cross sectional area (m2)	Second moment of area (m4)
1	Link ab	0.62	$\phi = 0.080$	$5.026*10^{-3}$	$2.01*10^{-6}$
2	Link cd	0.62	$\phi = 0.080$	$5.026*10^{-3}$	$2.01*10^{-6}$
3	Link ef	0.62	$\phi = 0.080$	$5.026*10^{-3}$	$2.01*10^{-6}$
4	Link gh	0.62	$\phi = 0.080$	$5.026*10^{-3}$	$2.01*10^{-6}$
5	Link aecg	0.47	0.280*0.100	$28*10^{-3}$	$23.33*10^{-6}$
6	Link bfdh	0.47	0.280*0.100	$28*10^{-3}$	$23.33*10^{-6}$
7	Cylinder rod	0.35	0.150	$117.81*10^{-3}$	$24.85*10^{-6}$

3.2.2.1 Compression mode :

$$F_{TC} = F_{pc} - F_m \qquad (3.5)$$

- F_{TC} : the total force in the compression mode .
- F_m : the Force resulting from the mass of the rod .
-

$$F_m = D * V * g \qquad (3.6)$$

- D : the density of steel = 7700 Kg/m^3 .
- V : volume = $\pi r_2 h$.
- g : Gravity acceleration = $9.81 m/s^2$

$F_m = D * \pi r^2 h = 7700 * \pi * .075^2 * 0.416 * 9.81 = 555.3N$

$F_{TC} = F_{pc} - F_m = 1{,}879.886 * 10^3 - 555.3 = 1.8$ MN

4

Chapter 4

Achievements

4.1 Old system changes

We conducted a field study to inspect elements of the old system of machine to determine if the elements are able to work well or not as well as if the elements can be used again in the new system which is to be accomplished. The following table (4.1) shows the results of this study

Table 4.1: A table showing the status of the elements of the old system

NO.	Element	Element case	Possibility to use	Remove the element
The mechanical structure :				
1	The lower base	✓	✓	-
2	Hex nut	✓	✓	-
3	The main rod	✓	✓	-
4	The upper base	✓	✓	-
Hydraulic system :				
5	Oil container	✓	✓	-
6	Hydraulic piston	✓	✓	-
7	Electrical motor	✓	✓	-
8	Directional control valves	✓	✓	-
9	Oil pump	✓	✓	-
10	Oil transfer pipelines	✓	✓	-
System of test sample installation :				
11	Tensile test	✓	✓	-
12	Compression test	✓	✓	-
The electrical system				
13	Main controller	×	×	✓
14	Pressure sensor	×	×	×
15	The deflection sensor	×	×	✓
16	Electric wires	×	×	✓

4.2 The operation system

The special program was designed to operate the machine, divided into three parts.

4.2.1 The User Interface:

Page (1): Home page:

The following figure (4.1) shows the first page for the program which enable the user to choose the type of the test that he want to do and through it transfer to the all program pages:

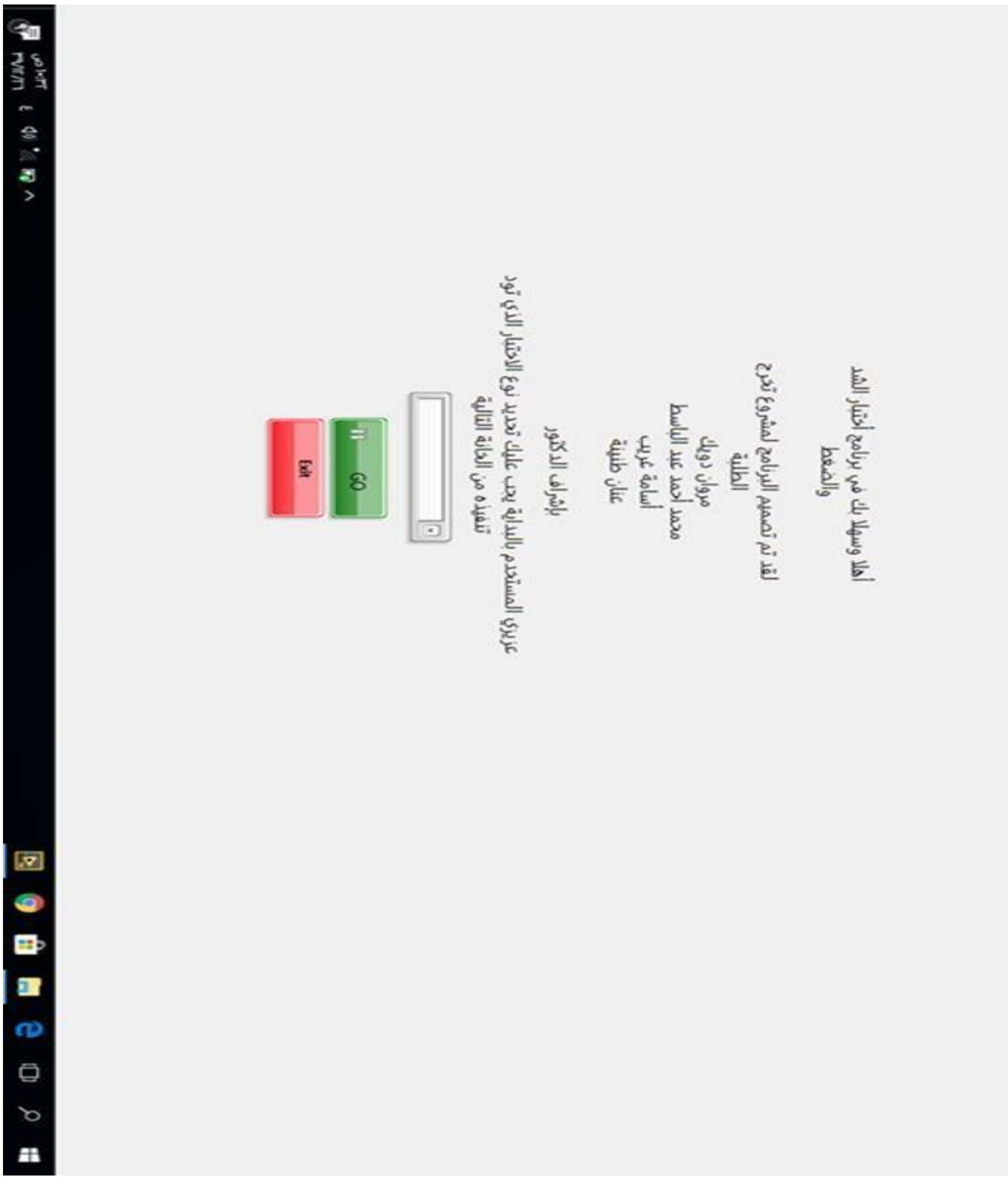


Figure 4.1: Home page.

Page (2): Manual mode:

This block diagram enables us to control the different unit of the system also monitoring the inlets and the outlets of the system. And the following figure (4.2) and (4.3) shows its page:

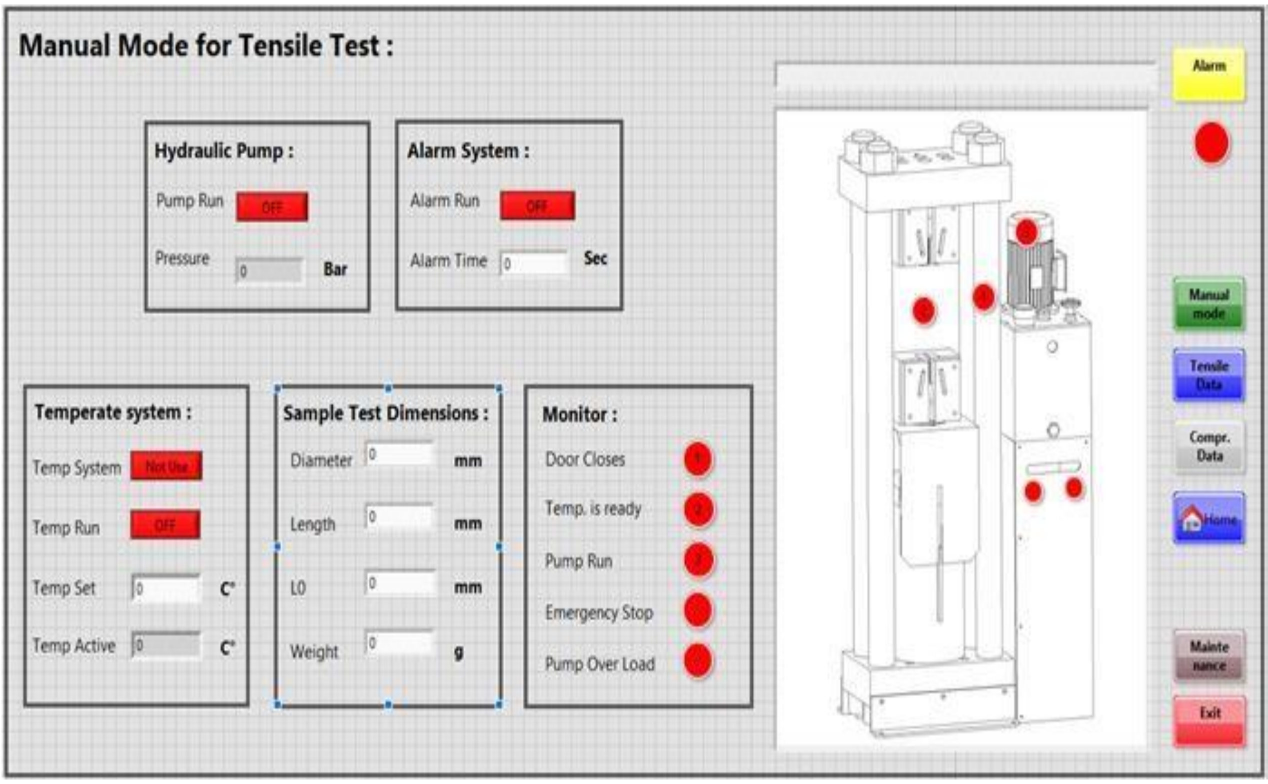


Figure (4.2): Manual mode of tensile test.

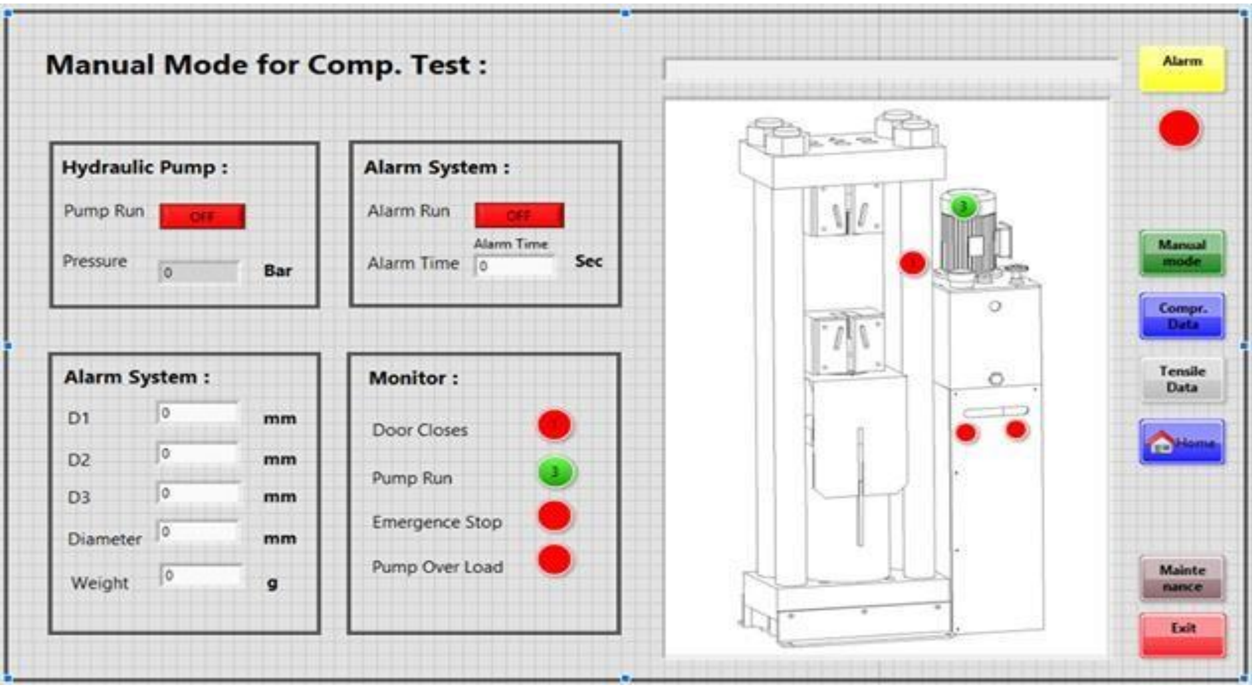


Figure (4.3): Manual mode of compression test.

Page 3: Tensile test

Through this page the user is enable to do the tension test after enter some of the required parameters that necessary to do the test, also he can monitoring the data of the test directly, and figure (4.4) shows the page:

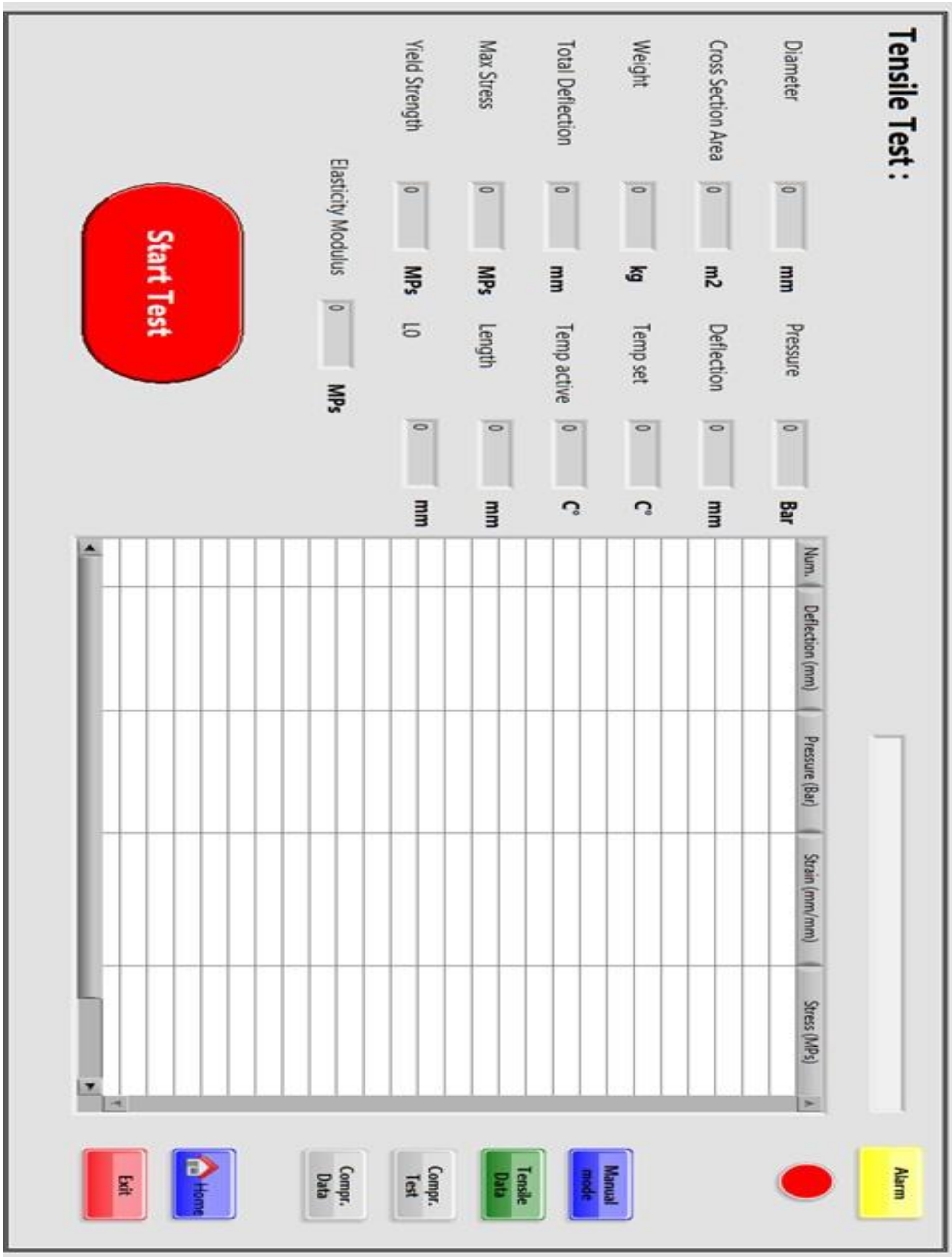


Figure 4.4: Tensile test page

Page (4): Compression test:

Through this page the user is enable to do the compression test after enter some of the required parameters that necessary to do the test, also he can monitoring the data of the test directly, and figure (4.5) shows the page:

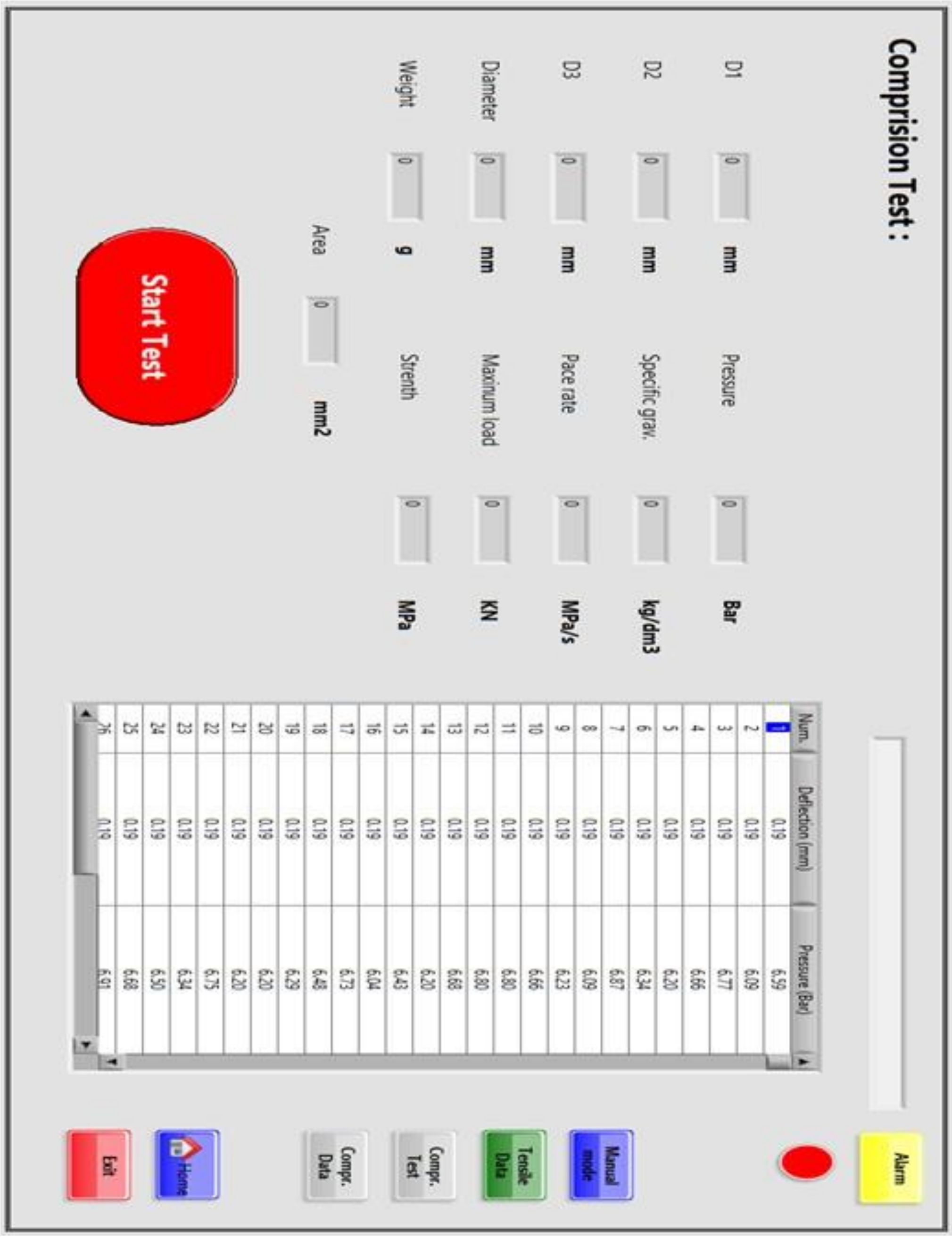


Figure (4.5): Compression test page.

Page (5): Alarm system:

This page illustrate that when there is an error, the user can now why did the error appeared in addition to determine the date of the error and reset it as shown in figure (4.6):

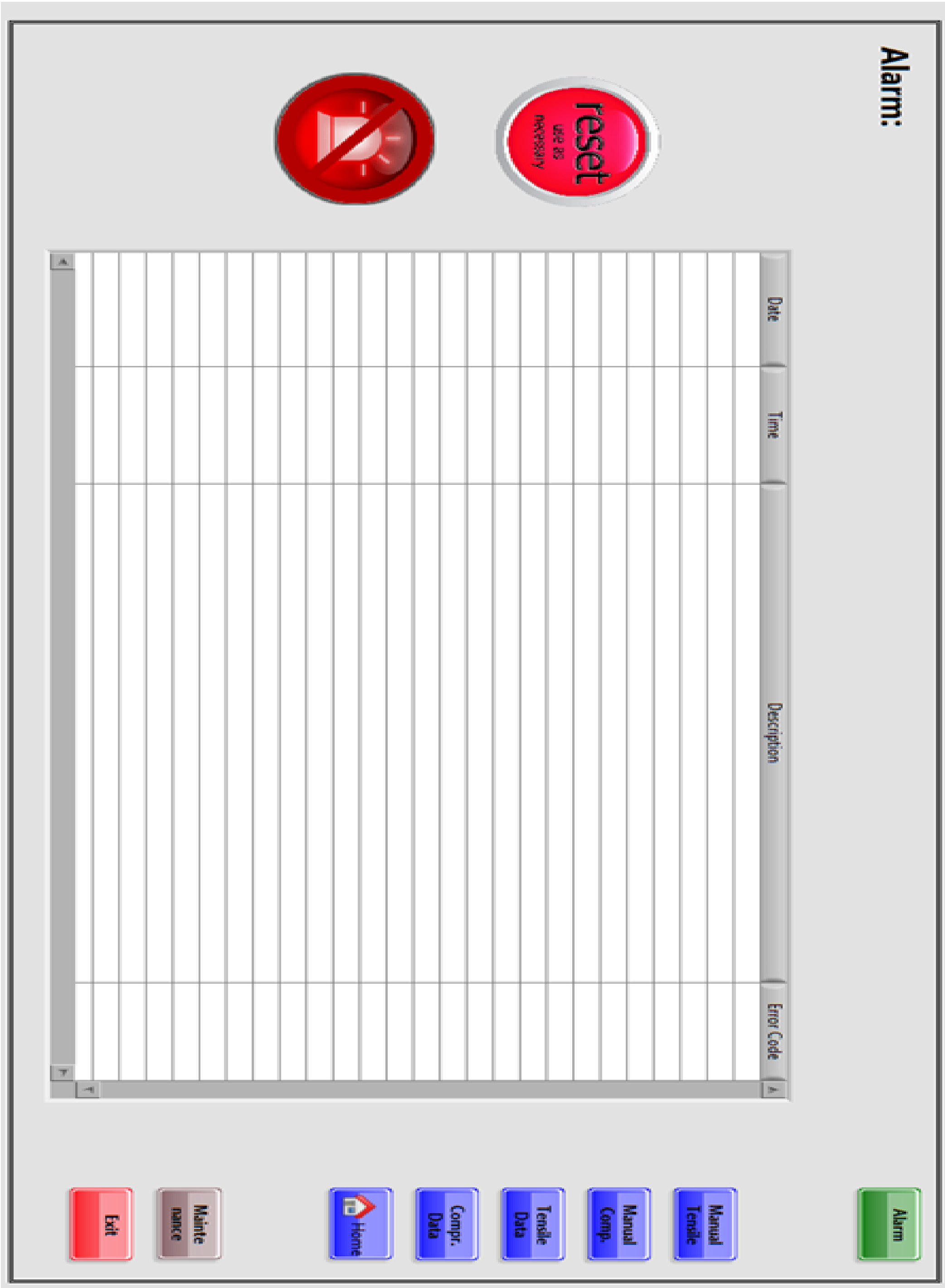
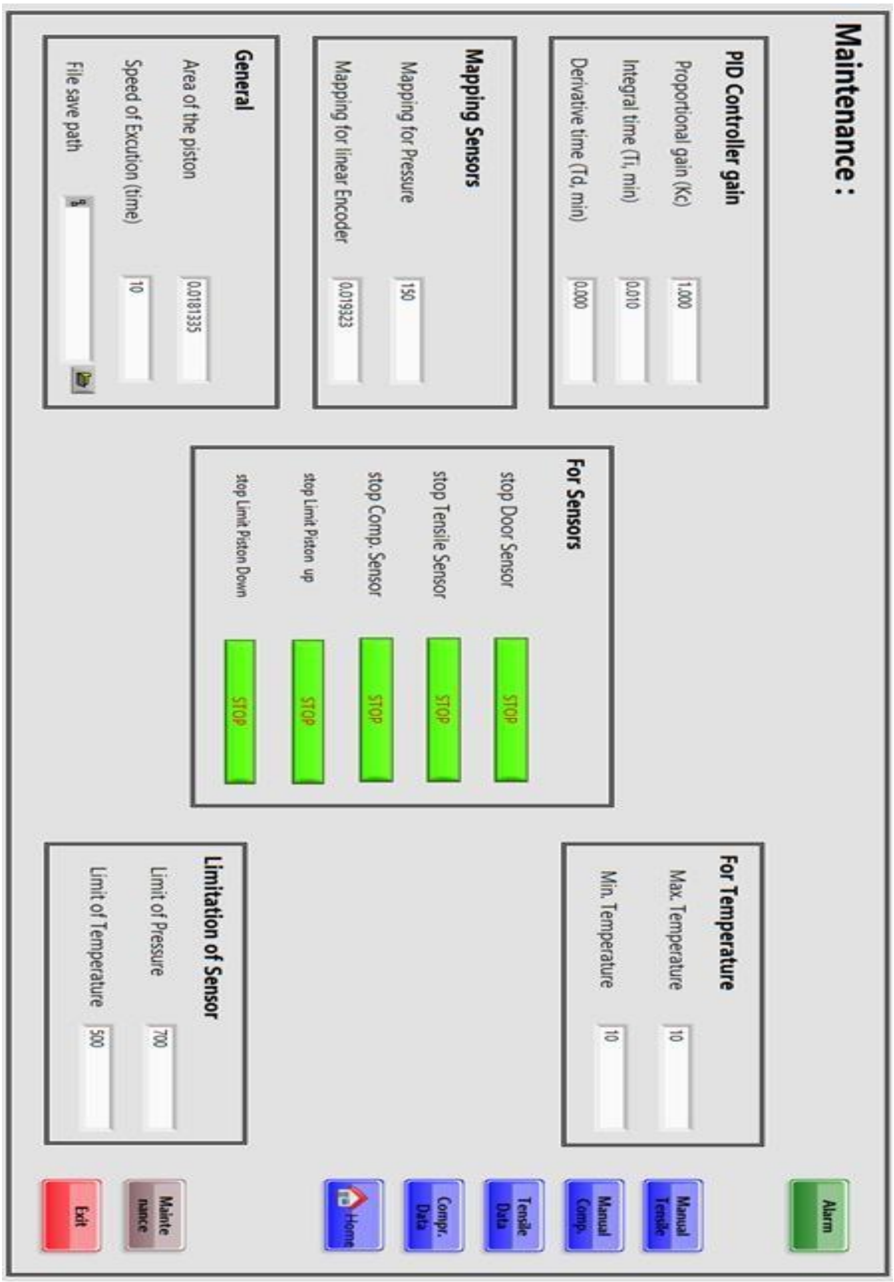


Figure (4.6): Alarm system page.

Page (6): maintenance page:

No one can enter to this page except the competitors to make substantial changes and these changes specialized in the precise settings which are special in the celebration of the pressure, deflection and the constants of the PID controller and the others. And that is shown in the following figure (4.7):



4.2.3 Download icon

The work of the file download so the user can download the program on any device, if a malfunction occurs in the computer used with the machine it can change the computer without the need to change the program and payment of sums. Fig (4.8): shows installation of the program.

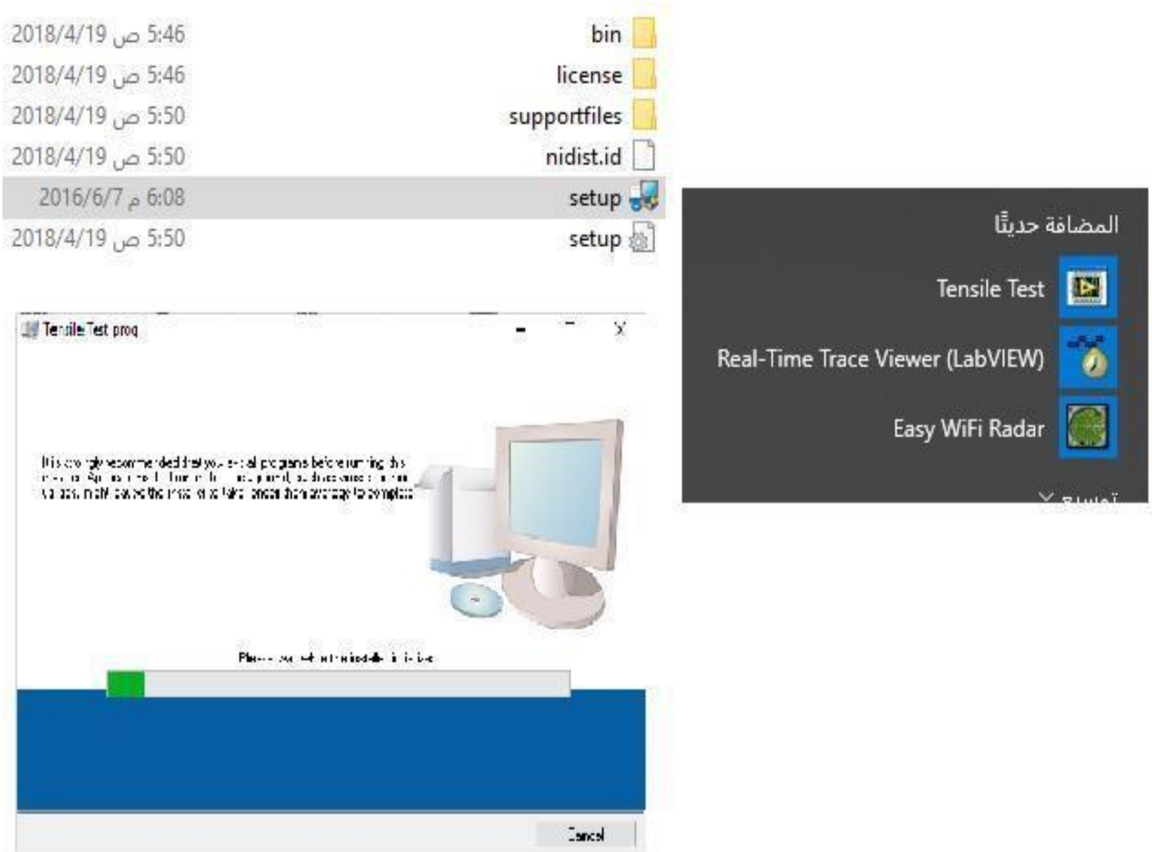


Figure 4.8: installation of the program.

4.3 The maximum stress of the machine

$$\sigma = \frac{F}{A} \quad , \sigma = S_{ut}$$

$$S_{ut} = \frac{F_{PT}}{A}$$

$$A = \frac{\pi}{4} D^2 = \frac{\pi}{4} * 0.025^2 = 4.91*10^{-4} m^2$$

$$S_{ut} = \frac{F_{PT}}{A} = \frac{1069.31436 *10^3}{4.91*10^{-4}} = 2.17783 GPa$$

We should use a material that have an ($S_{ut} \leq 2.17783 GPa$)

4.4 Heating system

4.4.1 The design:

The best design that can be chosen for the heating system is one which shown in figure (4.9).

Figure 4.9 : Hardware for temperature system.

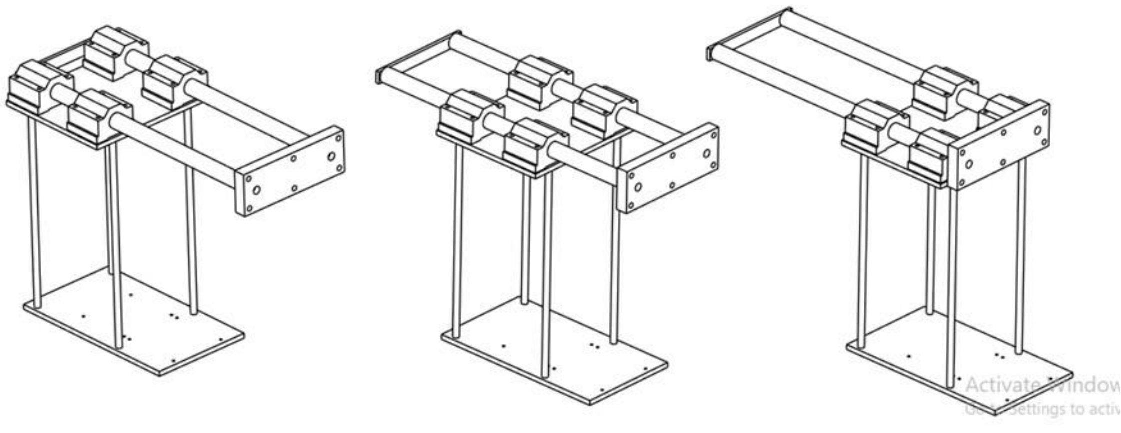
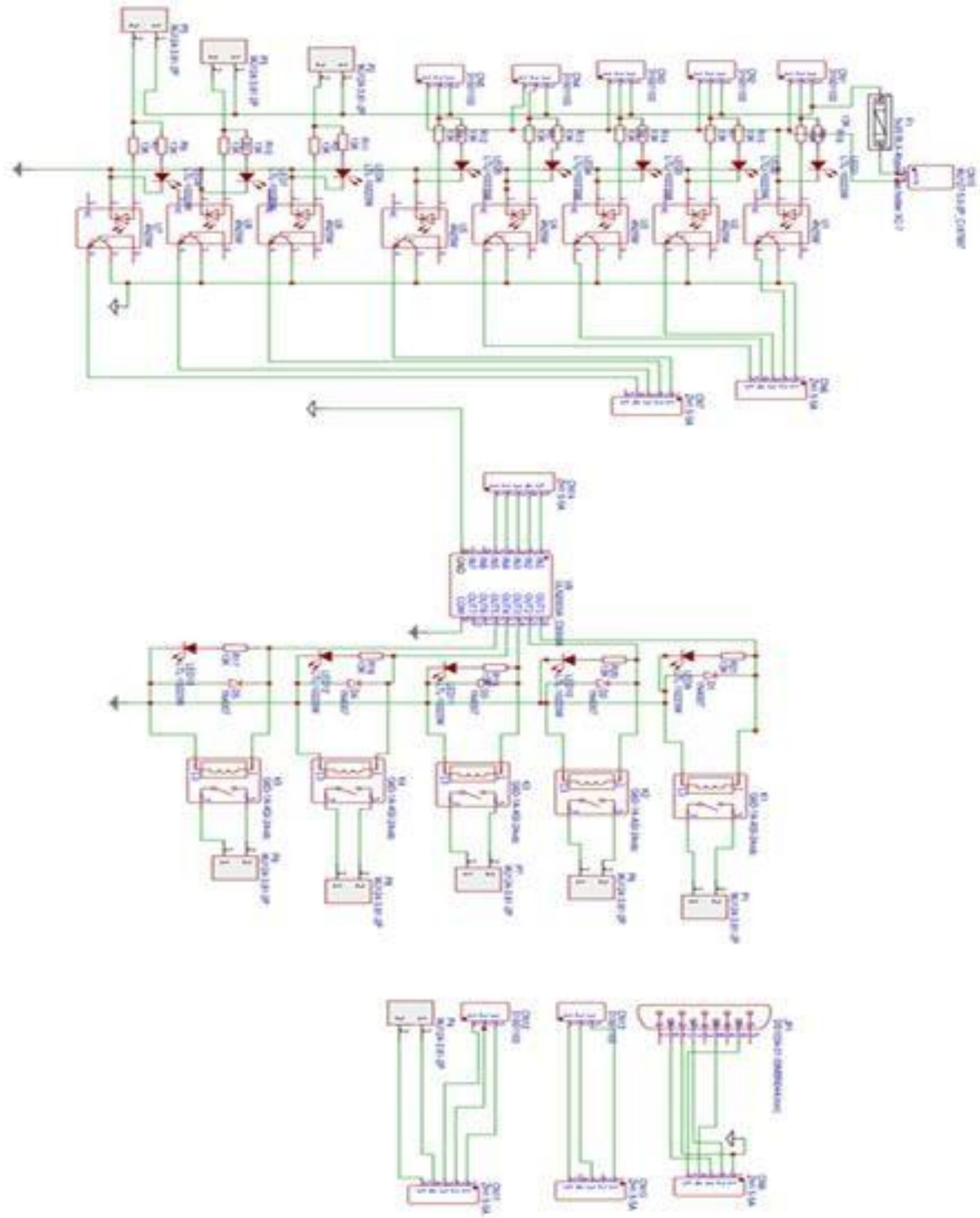


Figure 4.10: By installing heat system on the machine.

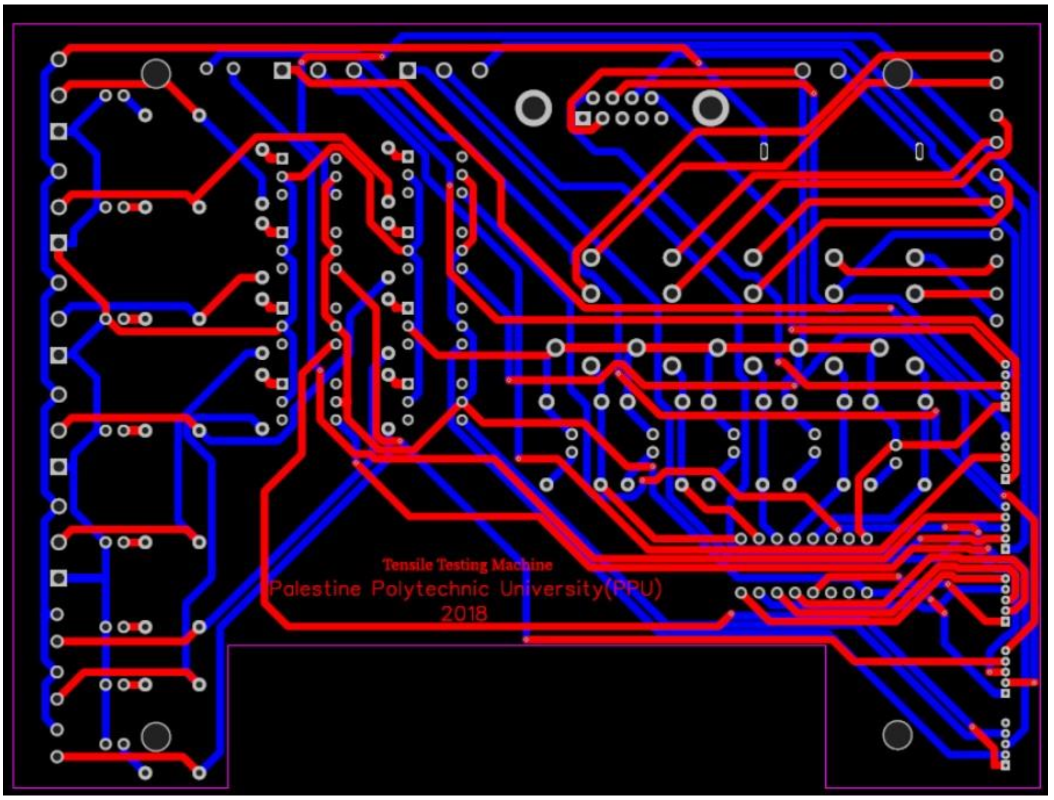
4.5 Insulation and protecting board

4.5.1 Electronic components delivery plan:

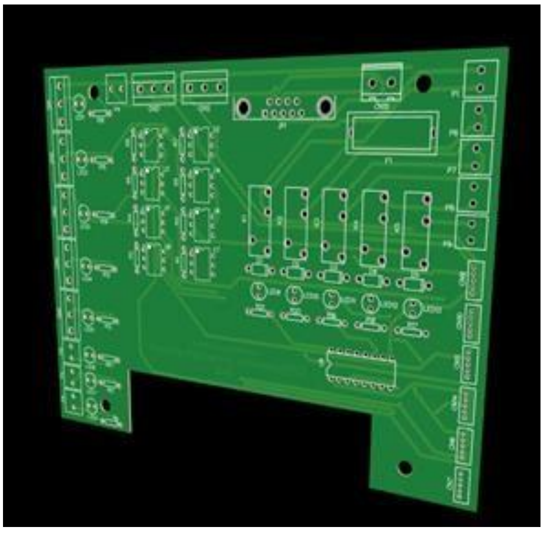
The following chart explain the shows the “PCB” board layout for protecting the “DAQ” control unit.

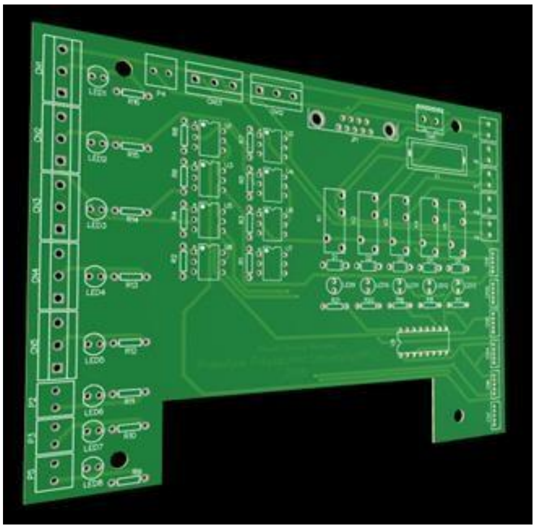


4.5.2 PCB design:



4.5.3 PCB final form:





4.5.3 Some of test results (stress-strain curves):

The below curves show the stress-strain curves of some steel specimens test with a 10 mm Diameter and 50 cm length, these curves are showing the difference between the results before and after the modifications that has been made to the way of tighten the test specimen.

By using the existed way of tighten; there were problems in performing the test. These problems are:

- Brake in the piston.
- Slipping in the specimen during the test.
- Repeating of readings (reached to thousand reading).

Because of these problems, the results were as shown in the following figure (4.11) (before doing the modifications):

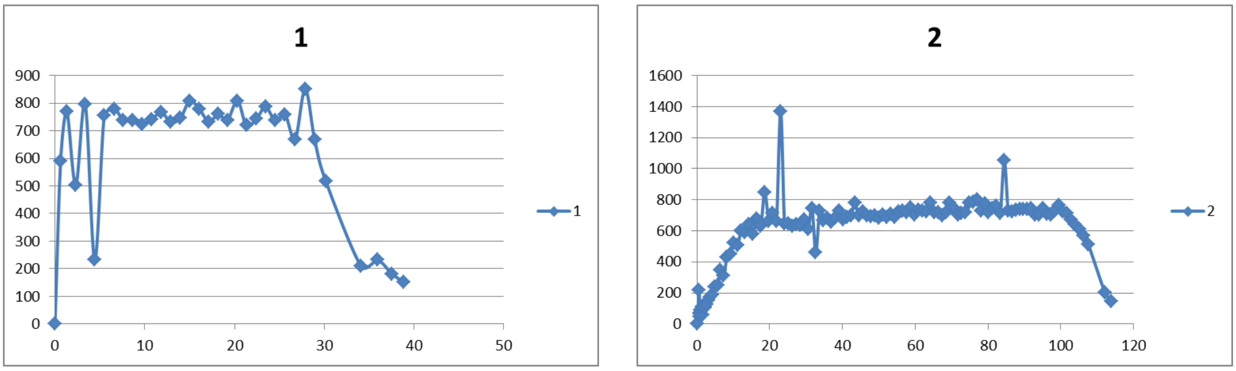


Figure (4.11): Stress-Strain curves of some steel specimens test before modifications

To solve these problems, a tighten tongs were proposed and designed to avoid the slipping which was the main cause of the irregularity of the readings in the above figures. These tongs are as shown in the following figure (4.12):

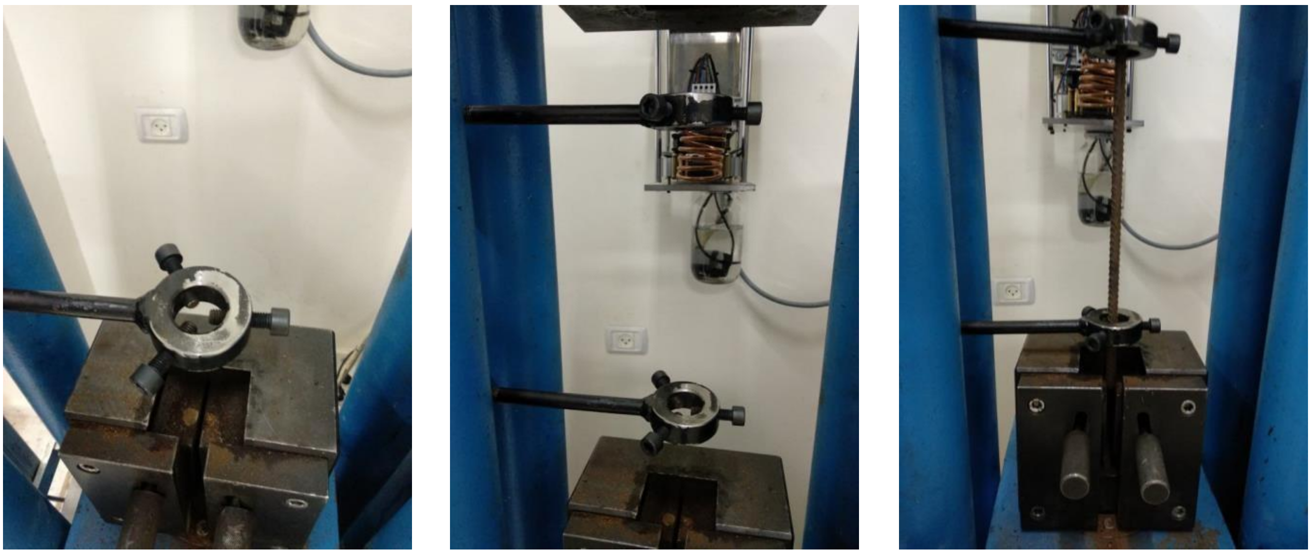


Figure (4.12): The currently way of tighten tongs.

After doing the required modification, the results became better than the previous one and the following figure (4.13) show that:

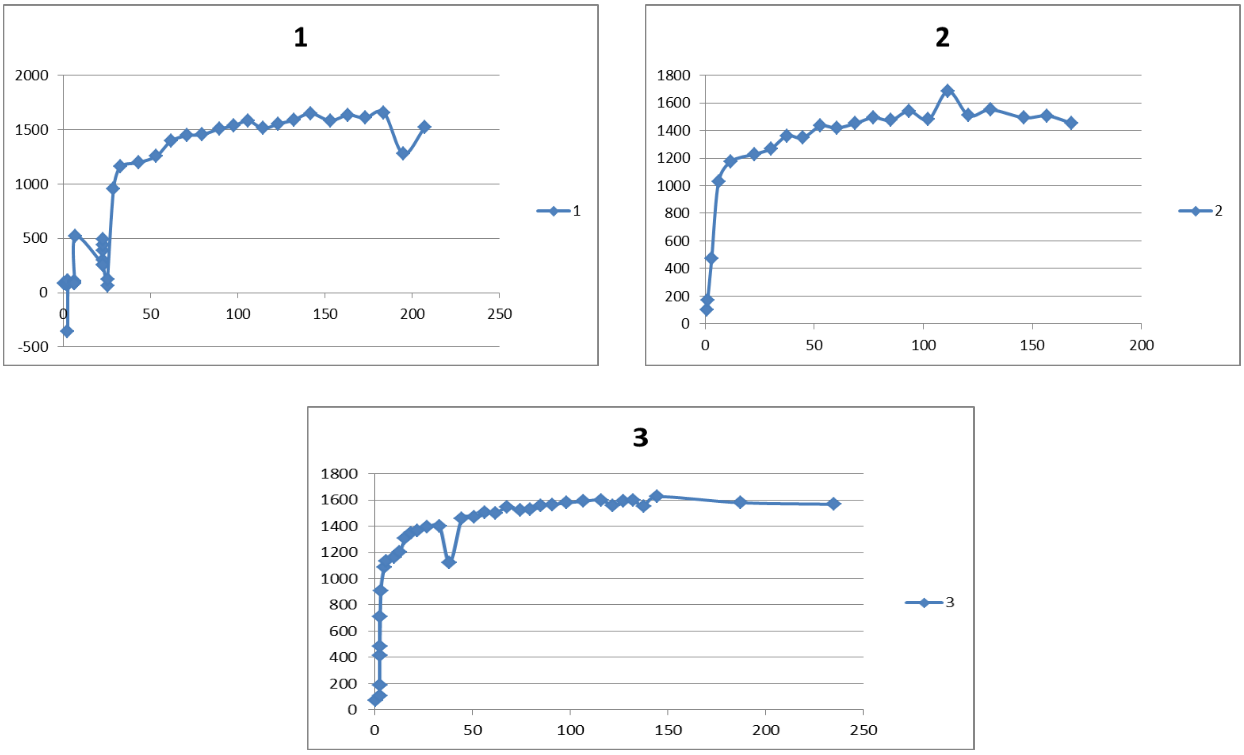


Figure (4.13): Stress-Strain curves of some steel specimens test after modifications.

But these tongs are expected to make a slipping for the specimen in future, which leads us to find another way to avoid this problem, therefore it is recommended to design the following way of tighten as shown in the figure (4.14). The tighten heads are simply a lathe machine tighten heads with a suitable diameters.

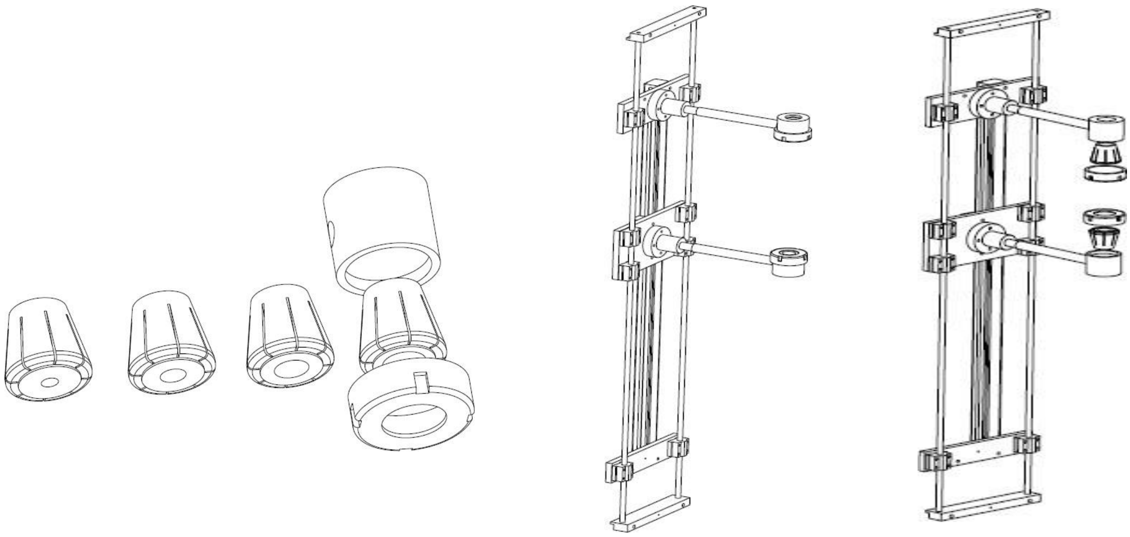


Figure (4.14): The recommended way of tighten tongs.

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[1] J T. Dewolf , of Materials, 6th Edition, 2007 by John Wiley & Sons, 0-471-73696-1.

[2] J.R. Davis ,Davis & Associates , Tensile Testing , 2th Edition , 2004 ASM International, 0-87170-806-X.

[3] J. Outinen , p. Mäkeläinen, 2002, mechanical properties of structural steel at elevated temperatures and after cooling down

[4] http://www.3r-labo.com/images/Docs/anglais/Universal-Testing-Machines-3R-GB.pdf

[5] University College of Southeast Norway , Hans-Petter Halvorsen, book Data Acquisition in LabVIEW

Low-Cost, Bus-Powered Multifunction DAQ for USB, National Instruments,

[6] M5200 Industrial Pressure Transducer , ETE connectivity

[7] [12]GT05 GLASS GRATING LINEAR TRANSDUCER Technical Specifications , zs system

[8] Manufacturer of Custom Temperature Sensors

[9] hp://www.thermx.com/Multipoint%20thermocouple/Multipoint_Thermocouple.htm

Appendix A

Datasheet

NI 6034E/6035E/6036E Family Specifications

This document lists the I/O terminal summary and specifications for the devices that make up the NI 6034E/6035E/6036E family of devices. This family includes the following devices:

- NI PCI-6034E
- NI PCI-6035E
- NI DAQCard-6036E
- NI PCI-6036E

I/O Terminal Summary

Note With NI-DAQmx, National Instruments revised its terminal names so they are easier to understand and more consistent among NI hardware and software products. The revised terminal names used in this document are usually similar to the names they replace. For a complete list of Traditional NI-DAQ (Legacy) terminal names and their NI-DAQmx equivalents, refer to *Terminal Name Equivalents* of the *E Series Help*.

Table 1. I/O Terminals

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
AI <0..15>	AI	100 GΩ in parallel with 100 pF	25/15	—	—	—	±200 pA
AI SENSE	AI	100 GΩ in parallel with 100 pF	25/15	—	—	—	±200 pA
AI GND	—	—	—	—	—	—	—
AO 0[†]	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	—	—
AO 1[†]	AO	0.1 Ω	Short-circuit to ground	5 at 10	5 at –10	—	—
AO GND	—	—	—	—	—	—	—
D GND	—	—	—	—	—	—	—

Table 1. I/O Terminals (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
+5 V	—	0.1 Ω	Short-circuit to ground	1 A fused	—	—	—
P0.<0..7>	DIO	—	V_{CC} + 0.5	13 at (V_{CC} – 0.4)	24 at 0.4	1.1	50 kΩ pu
AI HOLD COMP	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
EXT STROBE*	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 0/ (AI START TRIG)	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 1/ (AI REF TRIG)	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 2/(AI CONV CLK)*	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 3/ CTR 1 SOURCE	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 4/CTR 1 GATE	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
CTR 1 OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 5/ (AO SAMP CLK)*	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 6/ (AO START TRIG)	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 7/ (AI SAMP CLK)	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 8/ CTR 0 SOURCE	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
PFI 9/ CTR 0 GATE	DIO	—	V_{CC} + 0.5	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
CTR 0 OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu

Table 1. I/O Terminals (Continued)

Terminal Name	Terminal Type and Direction	Impedance Input/ Output	Protection (V) On/Off	Source (mA at V)	Sink (mA at V)	Rise Time (ns)	Bias
FREQ OUT	DO	—	—	3.5 at (V_{CC} – 0.4)	5 at 0.4	1.5	50 kΩ pu
* Indicates active low. † NI 6035E/6036E only. AI = Analog Input DIO = Digital Input/Output pu = pull-up AO = Analog Output DO = Digital Output **Note**: The tolerance on the 50 kΩ pull-up resistors is large. Actual value might range between 17 kΩ and 100 kΩ.							

Specifications

The following specifications are typical at 25 °C unless otherwise noted.

Analog Input

Input Characteristics

Number of channels ..... 16 single-ended or 8 differential (software-selectable per channel)

Type of A/D converter (ADC) .... Successive approximati

on Resolution .... 16 bits, 1 in

65,536

Max sampling rate........ 200 kS/s guaranteed

Input signal ranges

Range (Software-Selectable)	Bipolar Input Range
20 V	±10 V
10 V	±5 V
1 V	±500 mV
100 mV	±50 mV

Input coupling .... DC

Max working voltage (signal + common mode) Each input should remain within ±11 V of ground

Overvoltage protection

Signal	Powered On (V)	Powered Off (V)
AI <0..15>, AI SENSE	±25	±15

FIFO buffer size
NI DAQCard-6036E .1,024 samples (S)
NI 6034E, NI 6035E,
NI PCI-6036E ....512 S

DMA (PCI only) Channels
....
1

Data sources/destinations Analog input, analog output, counter/timer 0, or counter/timer 1

Data transfers ....Direct memory access (DMA)[1], interrupts, programmed I/O

DMA[1] modes ....Scatter-gather (single transfer, demand transfer) Configuration memory size

......................................512 words

[1] DMA is not available on the NI DAQCard-6036E.

Accuracy Information (NI 6034E, NI 6035E, NI PCI-6036E Only)

Nominal Range at Full Scale (V)	Absolute Accuracy							Relative Accuracy Resolution (μV)	
	% of Reading		Offset (μV)	Noise + Quantization (μV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		
	24 Hours	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
±10	0.0546	0.0588	±1601	±933	±82.4	0.0010	7.56	1,085	108.5
±5	0.0146	0.0188	±811	±467	±41.2	0.0005	1.79	542	52.24
±0.5	0.0546	0.0588	±100	±56.2	±5.04	0.0010	0.399	66.3	6.630
±0.05	0.0546	0.0588	±28.9	±28.2	±2.75	0.0010	0.0611	36.2	3.616

Note: Accuracies are valid for measurements following an internal E Series calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. NI recommends a one-year calibration interval. The Absolute Accuracy at Full Scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 points of averaged data. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

Accuracy Information (NI DAQCard-6036E Only)

Nominal Range at Full Scale (V)		Absolute Accuracy							Relative Accuracy Resolution (μV)	
		% of Reading		Offset (μV)	Noise + Quantization (μV)		Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)		
Positive Full Scale	Negative Full Scale	24 Hours	1 Year		Single Pt.	Averaged			Single Pt.	Averaged
+10	–10	0.0549	0.0591	2,602.05	1,500.21	137.329	0.0010	8.653	1,808.17	180.82
+5.0	–5.0	0.0149	0.0191	1,311.53	750.10	68.665	0.0005	2.337	904.08	90.408
+0.5	–0.5	0.0549	0.0591	150.053	84.319	7.782	0.0010	0.454	102.463	10.246
+0.05	–0.05	0.0549	0.0591	33.905	32.779	3.204	0.0010	0.067	42.191	4.219

Note: Accuracies are valid for measurements following an internal E Series calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. NI recommends a one-year calibration interval. The Absolute Accuracy at Full Scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 points of averaged data. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

Transfer Characteristics

Integral nonlinearity (INL)

NI DAQCard-6036E . ±3 LSB typ, ±6 LSB max

NI 6034E, NI 6035E, NI PCI-6036E............±1.5 LSB typ, ±3.0 LSB max

Differential nonlinearity (DNL)

NI DAQCard-6036E . ±1 LSB typ, +4 LSB, –2 LSB max

NI 6034E, NI 6035E, NI PCI-6036E............±0.5 LSB typ, ±1.0 LSB max

No missing codes

NI DAQCard-6036E . 15 bits

NI 6034E, NI 6035E, NI PCI-6036E .... 16 bits

Offset error

Pregain error after calibration ±1.0 μV max

Pregain error before calibration

NI DAQCard-6036E . ±3.0 mV max

NI 6034E, NI 6035E, NI PCI-6036E .... ±28.8 mV max

Postgain error after calibration

NI DAQCard-6036E . ±0.20 mV max

NI 6034E, NI 6035E, NI PCI-6036E .... ±157 μV max

Postgain error before calibration

NI DAQCard-6036E . ±50.1 mV max

NI 6034E, NI 6035E, NI PCI-6036E .... ±40 mV max

Gain error (relative to calibration reference) After calibration (gain = 1)

NI DAQCard-6036E ±77 ppm of

Amplifier Characteristics

Input impedance

Normal powered on... 100 GΩ in parallel with 100 pF

Powered off ... 820 Ω

Overload.................... 820 Ω

Input bias current

NI DAQCard-6036E . ±800 pA

NI 6034E, NI 6035E, NI PCI-6036E .... ±200 pA

Input offset current....... ±100 pA

Common-mode rejection ratio (CMRR), DC to 60 Hz

reading max

NI 6034E, NI 6035E, NI PCI-6036E........ ±74 ppm of reading max

Before calibration

NI DAQCard-6036E ±19,800 ppm of reading max

NI 6034E, NI 6035E, NI PCI-6036E........ ±18,900 ppm of reading max

Range	Bipolar
20 V	85 dB
10 V	85 dB
1 V	96 dB
100 mV	96 dB

Dynamic Characteristics

Bandwidth

Signal	Bandwidth
Small (–3 dB)	413 kHz
Large (1% THD)	490 kHz

Settling time for

full-scale step[1] NI

DAQCard-6036E

Range 100 mV, 1 V, 20 V ±4.5 LSB, 5 µs typ

Range 10 V ....±2 LSB, 5 µs typ

NI 6034E, NI 6035E, NI PCI-6036E

Range 100 mV ....±4 LSB, 5 µs typ

Range 1 to 20 V .....±2 LSB, 5 µs max

System noise (LSB_{rms},

including quantization) NI

DAQCard-6036E

Range 10 V, 20 V. 1.5

Range 1 V 1.7

Range 100 mV 7.0

Gain ≠ 1 with gain error

adjusted to 0 at gain = 1±200 ppm of reading max

[1] Accuracy values are valid for source impedances <1 kΩ. Refer to *Multichannel Scanning Considerations* of the *E Series Help* for more information.

NI 6034E, NI 6035E,

NI PCI-6036E Range

10 to 20 V

................................0.

8

Range 1 V 1.0
Range 100 mV 6.2

Crosstalk ....DC to 100 kHz

Adjacent channels .... 75 dB

Other channels .... 90 dB

Stability

Recommended warm-up time
NI DAQCard-6036E .30 minutes

NI 6034E, NI 6035E,
NI PCI-6036E ....15 minutes

Offset temperature coefficient

Pregain ....±20 μV/°C

Postgain.....................±175 μV/°C

Gain temperature coefficient±20 ppm/°C

Analog Output (NI 6035E/6036E Only)

Output Characteristics

Number of channels .....2 voltage

Resolution
NI DAQCard-6036E,
NI PCI-6036E ....16 bits, 1 in 65,536
NI 6035E...................12 bits, 1 in 4,096

Max update rate
DMA[1]..........................10 kHz, system-

dependent Interrupts..1 kHz, system-

dependent

Type of D/A converter (DAC) Double buffered,

multipl

ying FIFO buffer size...None

Data transfers ....DMA, interrupts, programmed I/O

DMA modes.................Scatter-gather (single

transfer, demand transfer)

Accuracy Information

Device	Nominal Range at Full Scale (V)	Absolute Accuracy					
		% of Reading			Offset (μV)	Temp Drift (%/°C)	Absolute Accuracy at Full Scale (mV)
		24 Hours	90 Days	1 Year			
NI DAQCard-6036E	±10	0.0091	0.0111	0.0133	1.22	0.0005	2.547
NI 6035E	±10	0.18	0.02	0.022	5.93	0.0005	8.127
NI PCI-6036E	±10	0.009	0.011	0.013	1.1	0.0005	2.417

Note: Accuracies are valid for measurements following an internal E Series calibration. Averaged numbers assume dithering and averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. NI recommends a one-year calibration interval. The Absolute Accuracy at Full Scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 points of averaged data. Go to `ni.com/info` and enter info code `rdspec` for example calculations.

[1] DMA is not available on the NI DAQCard-6036E.

Transfer Characteristics

INL, after calibration NI DAQCard-6036E,
NI PCI-6036E .... ±2 LSB max
NI 6035E ....±0.3 LSB typ, ±0.5 LSB max

DNL .... ±1.0 LSB max

Monotonicity
NI DAQCard-6036E,
NI PCI-6036E .... 16 bits, guaranteed after calibration
NI 6035E. 12 bits, guaranteed after calibration

Offset error
After calibration
NI DAQCard-6036E,
NI PCI-6036E .... ±305 μV max
NI 6035E................ ±1.0 mV max
Before calibration
NI DAQCard-6036E ±60 mV max
NI 6035E................ ±200 mV max
NI PCI-6036E .... ±44 mV max

Gain error (relative to internal reference) After calibration
NI DAQCard-6036E,
NI PCI-6036E .... ±30.5 ppm
NI 6035E................ ±100 ppm
Before calibration
NI DAQCard-6036E,
NI PCI-6036E .... ±0.50%
NI 6035E................ ±0.75%

Voltage Output

Range .... ±10 V

Output coupling .... DC

Output impedance .... Ω max

Current drive .... ±5 mA max

Protection .... Short-circuit to ground

Power-on state (steady state)
NI DAQCard-6036E . ±60 mV
NI 6035E................... ±200 mV
NI PCI-6036E .... ±44 mV

Initial

power-up

glitch

Magnitud

e

NI DAQCard-6036E ±1.6 V
NI 6035E................±1.1 V
NI PCI-6036E ....±2.2 V

Duration

NI DAQCard-6036E 545 ms
NI 6035E................2.0 ms
NI PCI-6036E ....42 µs

Power

reset

glitch

Magni

tude

NI DAQCard-6036E ±1.6 V
NI 6035E, NI PCI-6036E ±2.2 V

Duration

NI DAQCard-6036E 545 ms
NI 6035E................4.2 µs
NI PCI-6036E ....42 µs

Dynamic Characteristics

Settling time for full-scale step

NI DAQCard-6036E .5 µs to ±4.5 LSB accuracy
NI 6035E...................10 µs to ±0.5 LSB accuracy
NI PCI-6036E ....5 µs to ±1 LSB accuracy

Slew rate

NI DAQCard-6036E .5 V/µs
NI 6035E...................10 V/µs
NI PCI-6036E ....15 V/µs

Noise

NI DAQCard-6036E .160 µV_{rms}, DC to 400 kHz
NI 6035E.....200 µV_{rms}, DC to 1 MHz
NI PCI-6036E ....110 µV_{rms}, DC to 400 kHz

Mid-scale transition glitch (NI 6035E and NI PCI-6036E only) Magnitude

NI 6035E................±12 mV
NI PCI-6036E ....±10 mV

Duration

NI 6035E................2.0 µs
NI PCI-6036E ....1.0 µs

Stability

Offset temperature coefficient

NI DAQCard-6036E . ±150 μV/°C

NI 6035E.................. ±50 μV/°C

NI PCI-6036E .... ±35 μV/°C

Gain temperature coefficient

NI DAQCard-6036E . ±8 ppm/°C

NI 6035E.................. ±25 ppm/°C

NI PCI-6036E .... ±6.5 ppm/°C

Digital I/O

Number of channels ..... 8 input/output

Compatibility .... 5 V TTL/CMOS

Digital logic levels on P0.<0..7>

Level	Min	Max
Input low voltage	0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Input low current (V_{in} = 0 V)	—	–320 μA
Input high current (V_{in} = 5 V)	—	10 μA
Output low voltage (I_{OL} = 24 mA)	—	0.4 V
Output high voltage (I_{OH} = –13 mA)	4.35 V	—

Power-on state.............. Input (high-impedance),

50 kΩ pull-up to

+5 VDC Data transfers . Programmed I/O

Transfer rate (1 word = 8 bits)[1] 50 kwords/s, typ

Constant sustainable rate[1] 1 to 10 kwords/s, typ

Timing I/O

Number of channels

Up/down counter/timers 2

Frequency scaler 1

Resolution

Up/down counter/timers 24 bits

Frequency scaler .... 4 bits

Compatibility .... 5 V TTL/CMOS

Digital logic levels

Level	Min	Max
Input low voltage	0.0 V	0.8 V
Input high voltage	2.0 V	5.0 V
Output low voltage (I_{out} =5 mA)	—	4.35 V
Output high voltage (I_{out} = –3.5 mA)	0.4 V	—

Base clocks available
Up/down counter/timers 20 MHz, 100 kHz
Frequency scaler ....10 MHz, 100 kHz

Base clock accuracy .....±0.01%

Max external source frequency
up/down counter/timers 20 MHz

External source selections............... PFI <0..9>, RTSI <0..6>
(except DAQCard), analog trigger, software-selectable

External gate selections .... PFI <0..9>, RTSI <0..6>
(except DAQCard), analog trigger, software-selectable

Min source pulse duration 10 ns in edge-detect mode

Min gate pulse duration 10 ns in edge-detect mode

Data transfers
PCI up/down counter/timer DMA[2] (scatter-gather),
interrupts, programmed I/O
DAQCard up/down counter/timer ....Interrupts, programm

ed I/O Frequency scaler

......................................Programm

ed I/O

---

[1] Not guaranteed on the NI DAQCard-6036E.
[2] DMA is not available on the NI DAQCard-6036E.

Triggers

Digital Trigger

Purpose
Analog input.............. Start, reference, and pause trigger, sample $\sqrt{1,000\ h}$ clock

Analog output............ Start and pause trigger,
sample

clock Counter/timers . Source,
gate

External sources .... PFI <0..9>, RTSI <0..6>
(except

DAQCard) Compatibility 5 V TTL

Response .... Rising or falling edge

Pulse width................... 10 ns min

RTSI (PCI Only)

Trigger lines 7

Calibration

Recommended warm-up time
PCI .... 15 minutes
DAQCard .... 30 minutes

Interval .... 1 year

External calibration reference
.... Between 6 and 10 V

Onboard calibration reference
Level .... 5.000 V (±3.5 mV)
(over full

operating temperature, actual value stored in EEPROM)

Temperature coefficient ±5.0 ppm/°C max
Long-term stability.... ±15.0 ppm/

Power Requirement

PCI .... +5 VDC (±5%) at 0.9 A

DAQCard .... +5 VDC (±5%) at 0.3 A

Note Excludes power consumed through +5 V available at the I/O connector.

Power available at I/O connector
PCI .... +4.65 to +5.25 VDC
at 1 A
DAQCard .... +4.65 to +5.25 VDC
at 0.75 A

Physical

Dimensions

PCI (not including connectors) ... 17.5 cm × 10.6 cm (6.9 in. × 4.2 in.)

DAQCard ...... Type II PC Card

Weight

NI DAQCard-6036E . 32 g (1.1 oz)
NI PCI-6034E .... 152 g (5.3 oz)
NI PCI-6035E .... 165 g (5.8 oz)
NI PCI-6036E .... 114 g (4.0 oz)

I/O connector

PCI .... 68-pin male SCSI-II type
DAQCard .... 68-position female VHDCI

Maximum Working Voltage

Maximum working voltage refers to the signal voltage plus the common-mode voltage.

Channel-to-earth .... ±11 V, Installation Category I

Channel-to-channel ...... ±11 V, Installation Category I

Environmental

Operating temperature . 0 to 55 °C

Storage temperature ...... 20 to 70 °C

Relative humidity

NI DAQCard-6036E . 10 to 90%, noncondensing

NI 6035E, NI PCI-6036E .... 10 to 90%, noncondensing

Safety

NI PCI-6034E/6035E/6036E

The device meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

The device meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- IEC 60950, EN 60950
- UL 1950, UL 60950
- CAN/CSA-C22.2 No. 60950

Note For UL and other safety certifications, refer to the product label, or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

Emissions .... EN 55011 Class A at 10 m
FCC Part
15A above 1
GHz

Immunity...................... EN 61326:1997
A2:2001, Table 1

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Note For EMC compliance, you must operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC

Note Refer to the Declaration of

Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Figure 1. NI 6034E Pinout

Signal	Pin	Pin	Signal
AI 8	34	68	AI 0
AI 1	33	67	AI GND
AI GND	32	66	AI 9
AI 10	31	65	AI 2
AI 3	30	64	AI GND
AI GND	29	63	AI 11
AI 4	28	62	AI SENSE
AI GND	27	61	AI 12
AI 13	26	60	AI 5
AI 6	25	59	AI GND
AI GND	24	58	AI 14
AI 15	23	57	AI 7
AO 0	22	56	AI GND
AO 1	21	55	AO GND
NC	20	54	AO GND
P0.4	19	53	D GND
D GND	18	52	P0.0
P0.1	17	51	P0.5
P0.6	16	50	D GND
D GND	15	49	P0.2
+5 V	14	48	P0.7
D GND	13	47	P0.3
D GND	12	46	AI HOLD COMP
PFI 0/AI START TRIG	11	45	EXT STROBE
PFI 1/AI REF TRIG	10	44	D GND
D GND	9	43	PFI 2/AI CONV CLK
+5 V	8	42	PFI 3/CTR 1 SRC
D GND	7	41	PFI 4/CTR 1 GATE
PFI 5/AO SAMP CLK	6	40	CTR 1 OUT
PFI 6/AO START TRIG	5	39	D GND
D GND	4	38	PFI 7/AI SAMP CLK
PFI 9/CTR 0 GATE	3	37	PFI 8/CTR 0 SRC
CTR 0 OUT	2	36	D GND
FREQ OUT	1	35	D GND

NC = No Connect

Figure 2. NI 6035E/6036E Pinout

 370721C-01 Dec05

M5200

Industrial Pressure Transducer

SPECIFICATIONS

- **Wide Temperature Range**
- **Compact**
- **Variety of Pressure Ports and Electrical Configurations**
- **Optional Stainless Steel Snubber**
- **CE Compliant and Weatherproof**
- **UL Certified**
- **Gage, Sealed, Compound**

FEATURES

- Heavy Industrial CE Approval
- 10 V/m EMI Protection
- Reverse Polarity Protection on Input
- Short Circuit Protection on Output
- ±0.25% Accuracy
- ±1.0% Total Error Band
- Compact Outline
- -40°C to +125°C Operating Temperature
- Weatherproof

APPLICATIONS

- Industrial Process Control and Monitoring
- Advanced HVAC Systems
- Refrigeration Systems
- Automotive Test Stands
- Off-Road Vehicles
- Pumps and Compressors
- Hydraulic/Pneumatic Systems
- Agriculture Equipment
- Energy Generation and Management

The M5200 pressure transducers from the Microfused line of MEAS, with their modular design, offer maximum flexibility for different configurations. This latest series sets a new price performance standard for demanding commercial and heavy industrial applications. This series is suitable for measurement of liquid or gas pressure, even for difficult media such as contaminated water, steam, and mildly corrosive fluids.

The wetted material is made of either 17-4 PH or 316L stainless steel and the transducer's durability is excellent with no O-rings, welds or organics exposed to the pressure media. The M5200 is weatherproof and exceeds the latest heavy industrial CE requirements including surge protection. The circuit is protected from reverse wiring at input and short circuit at output.

This product is geared to the OEM customer for low to mid volumes. MEAS stands ready to provide a custom design of the M5200 where the volume and application warrants. Additional configurations not listed are either available or possible. Please inquire for further information.

STANDARD RANGES

Range (psi)	Range (Bar)	Gage	Sealed	Compound
0 to 050	0 to 3.5	•		•
0 to 100	0 to 007	•		•
	0 to 010	•		•
0 to 200		•		•
0 to 300	0 to 020	•		•
0 to 500	0 to 035	•		•
0 to 01k	0 to 070	•	•	•
0 to 03k	0 to 200	•	•	•
0 to 05k	0 to 350	•	•	•
0 to 07k	0 to 500	•	•	•
0 to 10k	0 to 700	•	•	•
0 to 15k	0 to 01k	•	•	•

Intermediate ranges available upon request

PERFORMANCE SPECIFICATIONS

Ambient Temperature: 25°C (unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Accuracy (combined non-linearity, hysteresis, and repeatability)	-0.25		0.25	%F.S.	BFSL
Isolation, Body to any Lead	100			MΩ	@500V_{DC}
Dielectric Strength			2	mA	@500V_{AC}, 1min
Pressure Cycles	1.00E+6			0~FS Cycles	
Proof Pressure	2X			Rated	
Burst Pressure	5X		20k psi	Rated	
Long Term Stability (1 year)	-0.25		0.25	%F.S.	
Total Error Band (17-4PH)	-1.0		1.0	%F.S.	Over compensated temperature range
Total Error Band (316L, ≤3k psi)	-1.5		1.5	%F.S.	Over compensated temperature range
Total Error Band (316L, >3k psi)	-2.0		2.0	%F.S.	Over compensated temperature range
Compensated Temperature	-20		+85	°C	
Operating Temperature	-40		+125	°C	Except cable 105°C max
Storage Temperature	-40		+125	°C	Except cable 105°C max
Load Resistance (R_L)	R_L > 100k			Ω	Voltage Output
Load Resistance (R_L)	< (Supply Voltage -9V) / 0.02A			Ω	Current Output
Current Consumption			5	mA	Voltage Output
Rise Time (10% to 90%)	<2ms (Voltage Output); <3ms (Current Output); Without Snubber				

Wetted Material 17-4PH or 316L Stainless Steel Port, 316L Stainless Steel Snubber Gage Pressure Reference Vent Under 1k psi, customer to ensure venting through mating connector Bandwidth DC to 1KHz (Typical)

Shock 50g, 11msec Half Sine Shock per MIL-STD-202G, Method 213B, Condition A

Vibration ±20g, MIL-STD-810C, Procedure 514.2, Fig 514.2-2, Curve L For custom configurations, consult factory.

Notes

Compensated Temperature: The temperature range over which the product will produce an output proportional to pressure within the specified performance limits.

Operating Temperature: The temperature range over which the product will produce an output proportional to pressure but may not remain within the specified performance limits.

Storage Temperature: The temperature range over which the product can be stored safely in occasions without pressure applied or power input and remains rated performance. Beyond this temperature range may cause permanent damage to the product.

All configurations are built with supply voltage reverse and output short-circuit protections.

CE Compliance

EN 55022 Emissions Class A & B

IEC 61000-4-2 Electrostatic Discharge Immunity (8kV contact/15kV air)

IEC 61000-4-3 Radiated, Radio-Frequency Electromagnetic Field Immunity (10V/m, 80M-1GHz)

IEC 61000-4-4 Electrical Fast Transient Immunity (1kV)

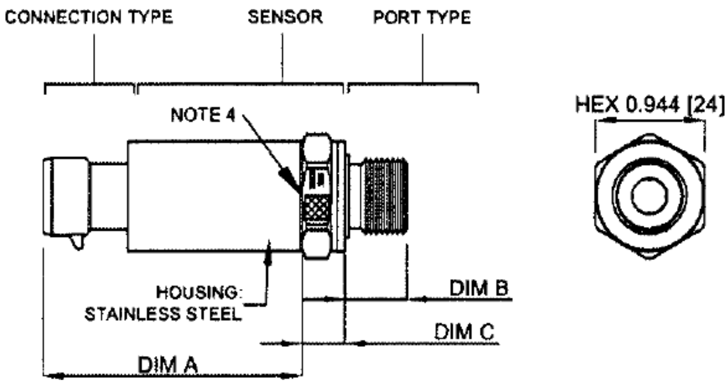
IEC 61000-4-5 Surge Immunity (V+ to V-: ±2KV/42Ω; L to Case: ±1KV/12Ω; V- to V_0: ±1KV/42Ω)

IEC 61000-4-6 Immunity to Conducted Disturbances Induced by Radio Frequency Fields (150K~80MHz, 10V level for voltage output models, 3V level for current output model)

IEC 61000-4-9 Pulse Magnetic Field Immunity (100A/m peak)

For all CE compliance tests, max allowed output deviation ±1.5 %F.S.

DIMENSIONS



Refer to installation instructions for recommended torque.

CODE	CONNECTION TYPE	DIM A
1	CABLE 2 FT	2.19 [55.6]
E	CABLE 3 FT	2.19 [55.6]
2	CABLE 4 FT	2.19 [55.6]
3	CABLE 10 FT	2.19 [55.6]
4	PACKARD CONNECTOR A	2.25 [57.2]
5	BAYONET CONNECTOR	1.94 [49.5]
6	FORM C	1.95 [49.5]
7	FORM A	2.10 [53.3]
9	PACKARD CONNECTOR B	2.25 [57.2]
D	M12 CONNECTOR	1.95 [49.5]
M	CABLE 1 M	2.19 [55.6]
N	CABLE 2 M	2.19 [55.6]
P	CABLE 5 M	2.19 [55.6]
R	CABLE 10 M	2.19 [55.6]
A	AMP CONNECTOR	2.24 [56.9]

Not
e:

PRESSURE PORT TYPE

CODE	PORT	DIM B	DIM C REF.
2	1/4-19 BSPP	0.547 [13.9]	0.366 [9.3]
3	G3/8 JIS B2351	0.615 [15.6]	0.366 [9.3]
4	7/16-20UNF MALE SAE J1926-2 STRAIGHT THREAD O- RING BUNA-N 90SH-904	0.508 [12.9]	0.366 [9.3]
5	1/4-18 NPT	0.600 [15.2]	0.366 [9.3]
6	1/8-27 NPT	0.390 [9.91]	0.366 [9.3]
B	G1/4 JIS B2351	0.547 [13.9]	0.366 [9.3]
E	1/4-19 BSPT	0.500 [12.7]	0.366 [9.3]
F	1/4-19 BSPP FEMALE (without snubber)	0.621 [15.8]	0.366 [9.3]
P	7/16-20UNF FEMALE SAE J513 STRAIGHT THREAD WITH INTEGRAL VALVE DEPRESSOR	0.430 [10.9]	0.444 [11.3]
N	7/16-20UNF FEMALE SAE J513 STRAIGHT THREAD	0.430 [10.9]	0.444 [11.3]
Q	M10 x 1.0 mm ISO 6149-2	0.449 [11.4]	0.366 [9.3]
S	M12 x 1.5 mm ISO 6149-2	0.531 [13.5]	0.366 [9.3]
U	G/14 DIN 3852 FORM E GASKET DIN3869-14 NBR	0.519 [13.2]	0.366 [9.3]
W	M20 x 1.5 mm ISO 6149-2	0.551 [14.0]	0.441 [11.2]
G	M14 x 1.5 mm ISO 6149-2	0.531 [13.5]	0.366 [9.3]

WIRING

Current Output Wiring				
CONNECTION	**+SUPPLY**	**-SUPPLY**	**NC. PINS**	**P REF VENT**
Bayonet	A	B	C,D,E	F
Packard, A	A	B	C	Hole Through Connector
Packard, B	B	A	C	Hole Through Connector
Cable	RED	BLK		In Cable
M12	1	3	2,4	Hole Through Connector
AMP/TE	1	2	3	Hole Through Connector
FORM C	1	2	3,4	Threads Through Connector
FORM A	1	2	3,4	Threads Through Connector

Voltage Output Wiring					
CONNECTION	**+SUPPLY**	**+OUTPUT**	**COMMON**	**NC. PINS**	**P REF VENT**
Bayonet	A	B	C	D,E	F
Packard, A	A	C	B		Hole Through Connector
Packard, B	B	C	A		Hole Through Connector
Cable	RED	WHT	BLK		In Cable
M12	1	2	3	4	Hole Through Connector
AMP/TE	1	3	2		Hole Through Connector
FORM C	1	2	3	4	Threads Through Connector
FORM A	1	3	2	4	Threads Through Connector

Notes:

1. NC pins are reserved for factory use only. **Customers should not use these connections**.
2. For cable connection, the drain wire is internally terminated to pressure port.

CONNECTION TYPES

CONNECTION	DESCRIPTION	MATING HOUSING P/N	MATING TERMINAL P/N	RUBBER SEAL P/N
Bayonet	BAYONET PTIH-10-6P OR EQUIV	PT06A-10-6S MIL-C-26482	-	-
Packard	3-PIN METRI-PACK 150	12078090	12103881, QTY 3	-
M12	BINDER SERIES 713, 09 3431 77 04 OR EQUIV	4-POS FEMALE CONNECTOR	-	-
AMP/TE	AMP/TE3-PINECONOSEALJ SERIES	174357-2 & 174358-7	171630-1 (AWG 20~24) 171662-1 (AWG 16~20) QTY 3	172746-1 (AWG 20~24) 172888-2 (AWG 16~20) QTY 3
FORM C	INDUSTRIAL STANDARD 9.4MM FORM C	HIRSCHMANN 933 024-100,OR, ATAM KD046000B7 (SEAL INCL.)	-	HIRSCHMANN 730 185-002
FORM A	DIN EN 175 301-803-A 18MM	HIRSCHMANN931969-100,OR, ATAMKA245000B4(SEALINCL.)	-	HIRSCHMANN 730 801-002

Note: Transmitter of gage pressure type requires vent to atmosphere on the pressure reference side. This is accomplished via cable from the transmitter (the end of the cable should be terminated to clean and dry area) or through the customer mating connector/cable assembly which has internal vent path.

Suggested vented M12 mating connector P/N MB12FWAFF04ST-4 and MB12FWAFF04ST-3 at www.finecables.com for 0.157"~0.236" and 0.236"~0.315" diameter cable respectively.

WEATHERPROOF

WEATHER-PROOF RATING	
CONNECTION	**IP CODE**
Bayonet	IP67
Packard	IP66
Cable	IP67
M12	IP67
AMP/TE	IP67
FORM C	IP65
FORM A	IP65

Note: Weatherproof ratings are met when the mating connectors are installed properly and the cable termination is to dry and clean area.

Pressure Rating

OUTPUTS

Code	Supply Voltage	Max Input Current	Output Signal	psi	bar
3	5 ± 0.25V, PROTECTED TO 30V	10mA	0.5V-4.5V RATIOMETRIC	20 – 15,000	1.3 – 1000
4	8 – 30V	10mA	1 – 5V		
5	9 – 30V	25mA	4 – 20mA		
6	8 – 30V	10mA	0 – 5V		
7	12 – 30V	10mA	0 – 10V		
8	8 – 30V	10mA	1 – 6V		
9	5 – 30V	10mA	0.5 – 4.5V		

ORDERING INFORMATION

M52 6 1 - 1 0 00 1 2 – 100P G

Output	
Code	Output
3	0.5 to 4.5V Ratiometric
4	1 to 5V
5	4 to 20mA
6	0 to 5V
7	0 to 10V
8	1 to 6V
9	0.5 to 4.5V

Pressure Reference	
G	Gauge
S	Sealed (≥1k psi)
C	Compound

Pressure Ranges	
PSI STD	BAR STD
050P	3.5B
100P	007B
200P	010B
300P	020B
500P	035B
01KP	070B
03KP	200B
05KP	350B
07KP	500B
10KP	700B
15KP	01KB

Compound pressure range is -14.7 to xxxpsig or -1 to xxxbarg. (e.g. 200PC: -14.7 to 200psig, 020BC: -1 to 20barg)

Connectors	
Code	Connection
1	Cable 2ft
E	Cable 3ft
2	Cable 4ft
3	Cable 10ft
4	Packard Connector A
5	Bayonet Connector
6	Form C
7	Form A
9	Packard Connector B
D	M12 Connector
M	Cable 1m
N	Cable 2m
P	Cable 5m
R	Cable 10m
A	Amp Connector

Pressure Port	
Code	Port
2	1/4-19 BSPP
3	G3/8 JIS B2351
4	7/16-20 UNF Male SAE J1926-2 Straight Thread O-Ring Buna 90SH ID8.92xW1.83mm
5	1/4-18 NPT
6	1/8-27 NPT
B	G1/4 JIS B2351
E	1/4-19 BSPT
F	1/4-19 BSPP Female
P	7/16-20UNF Female SAE J513 Straight Thread w/ Integral Valve Depressor
N	7/16-20UNF Female SAE J513 Straight Thread
Q	M10X1.0mm ISO 6149-2
S	M12X1.5mm ISO 6149-2
U	G1/4 DIN 3852 Form E Gasket DIN3869-14 NBR
W	M20X1.5mm ISO 6149-2
G	M14X1.5mm ISO 6149-2

Port Material	
Code	Description
0	17-4PH Stainless Steel
1	316L Stainless Steel

Cleaning	
0	No Selection
1	Oxygen Clean B40.1 Level IV
2	With Snubber

Label	
Code	Label Type
0	Adhesive Label
1	Laser Marking

Note: Refer to online installation instruction for recommended torque. Installation instructions are available on our website in English and Chinese.

NORTH AMERICA

EUROPE

ASIA

TE.com/sensorsolutions

Linear Scales

Installation Manual

Sterling's KA series of glass scales are designed and manufactured to deliver the optimal structure for rigidity with ease of installation and high precision. A modular range of accessory installation brackets make installations fast, easy, and accurate without the need to fabricate on site. Please refer to the following pages for installation and service data.

1. *Technical Specification:*

a. Pitch: 0.02mm (50 lines/mm)

b. Resolution: 1µm and 5µm

c. Accuracy: ±5µm and ±10µm (20@)

d. Range: 70 ~ 3000mm

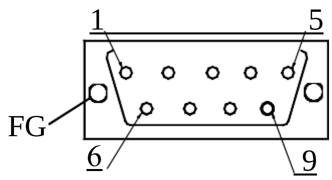
e. Max. Speed: 60 or 120m/min

f. Working Voltage: +5V (±5%) 80mA

g. Cable Length: 3m (various length available upon request)

h. Working Temperature: 0 ~45@

i. Plug Pin

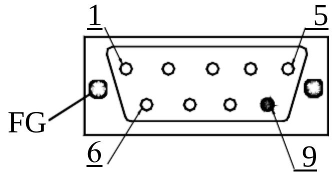


1) Applicable to the EIA-442-A signals output of KA-300, KA-500 and KA-600 NC scales using 9-pin sockets.

Pin	1	2	3	4	5	6	7	8	9
Signal	$\overline{A}$	OV	$\overline{B}$	Null	$\overline{Z}$	A	+5V	B	Z
Color	Green	Black	Blue	Red	Brown	Yellow	Pink	Orange	White

FG覲Connected to metal case for shielding.

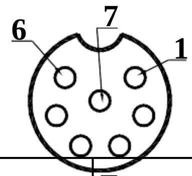
2) Applicable to the TTL signal output of KA-300, KA-500 and KA-600 scales using 9-pin sockets.



Pin	1	2	3	4	5	6	7	8	9
Signal	Null	OV	Null	Null	Null	A	+5V	B	Z
Color		Black				Green	Brown	Orange	White

FG覲connected to metal case for shielding.

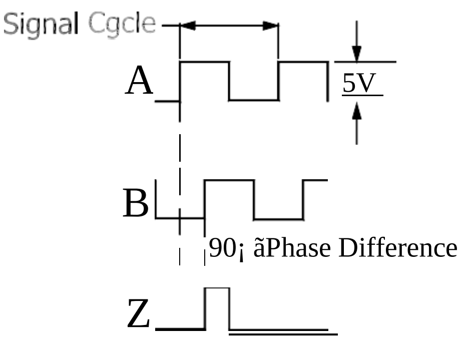
3) Applicable to the TTL signal output of KA-300, KA-500 and KA-600 scales with 7-pin sockets.



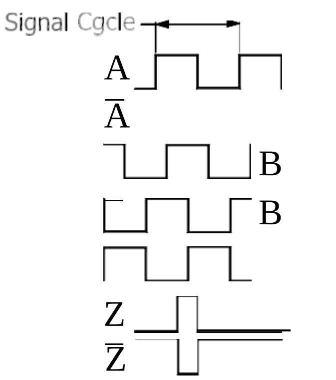
Pin	1	2	3	4	5	6	7
Signal	OV	Null	A	B	+5V	Z	Screen
Color	Black		Green	Orange	Brown	White	

j. Signal Specification

The TTL signal output:



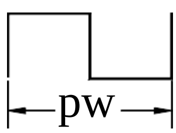
The EIA-442-A signal output:



k. Zero-Point Position: one every 500mm.

j. Cycle of the pulse signal output by grate scale (pw)

Resolution	Equivalent weight(pw)
5μm	20μm
1μm	4μm



2. Scale Structure:

The glass scale is composed mainly of the glass assembly and the reading head assembly (See Fig. 1).

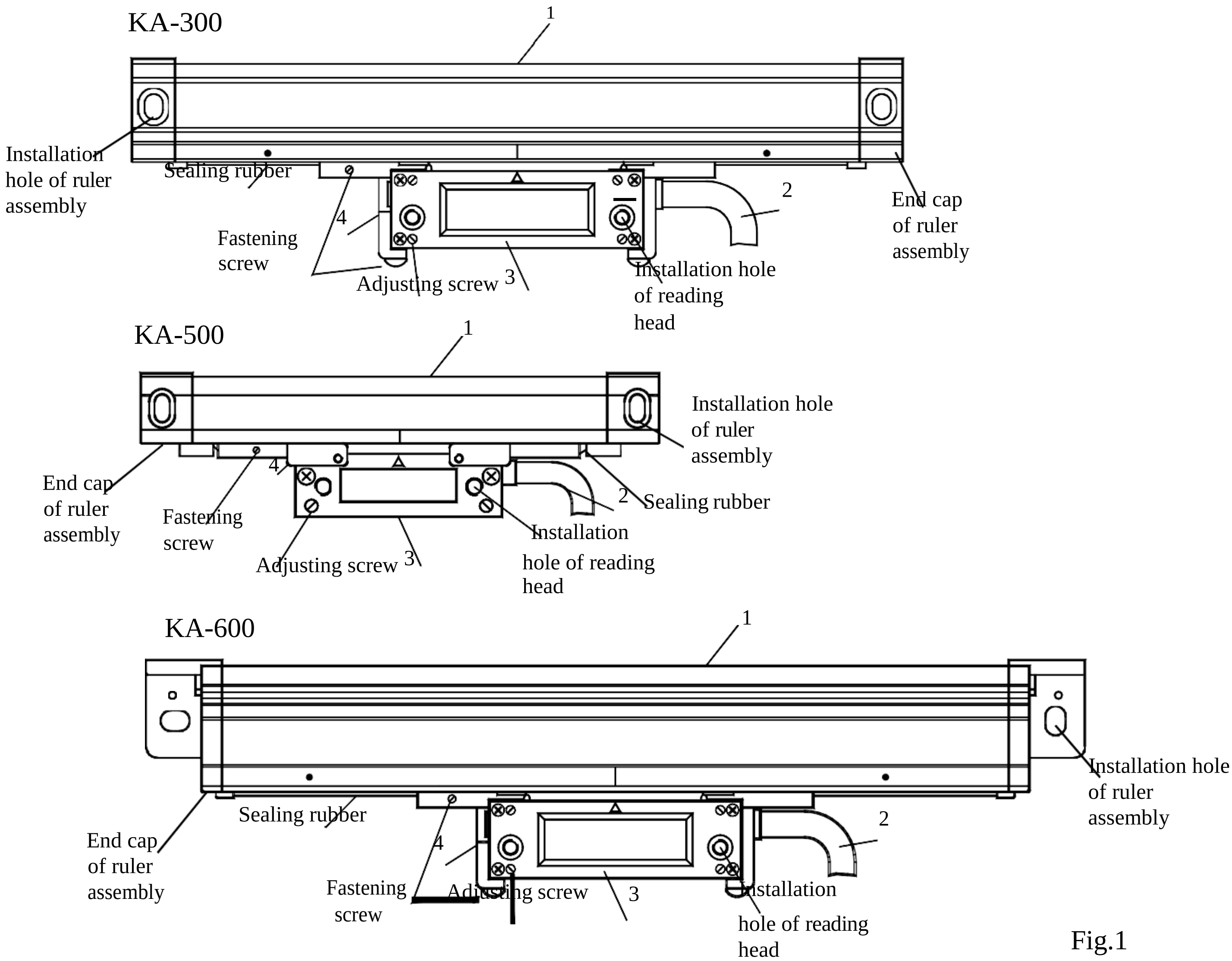


Fig.1

1. Scale Assembly
2. Cable
3. Reading Head
4. Fixed Junction Plate for Reading Head

3. Spare Parts

In order to install and apply the scales in various places, the company designs the following spare parts for them.

3.1 Cover Type A, for installation on finished surface, oil resistant and scrap proof (See Fig. 2).

3.2 Cover Type B and H, for installation on finished or unfinished surface, oil resistant and scrap proof, applicable to installation surface shorter than scales, contributive to the scale rigidity (See Fig. 3 and Fig. 7).

3.3 Economical Cover Type C, I and J, for installation on finished surface, a little inferior to Type A in liquid and scrap resistance (See Fig. 4, Fig. 8 and Fig. 10).

3.4 Economical Cover Type D and G, for installation on finished or unfinished surface, applicable to installation surface shorter than scales, a little inferior to Type B and H in liquid and scrap resistance, contributive to the scale rigidity (See Fig. 5).

3.5 Bearing Plate, for installation on finished or unfinished surface or surface shorter than scales, contributive to scale rigidity, not resistant to oil or scrap (See Fig. 6 and Fig. 9).

The user may select suitable parts according to the working environment and the installation condition.

KA-300觀

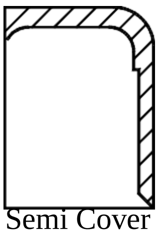


Fig. 2

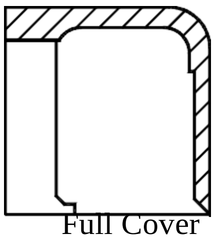


Fig. 3

Fig. 4

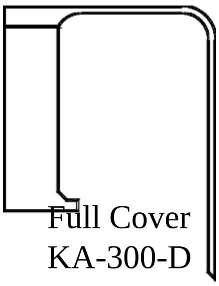


Fig. 5

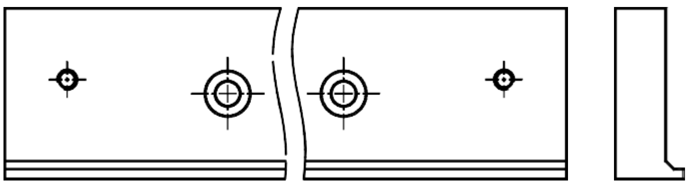
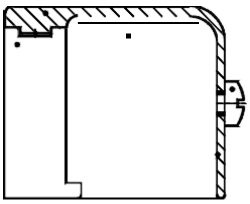


Fig. 6

KA-500覲

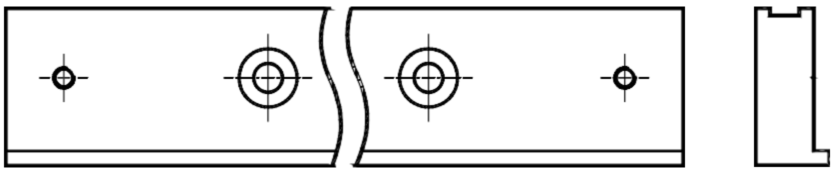


Full Cover
KA-500-
H

Fig. 7

Semi Cover
KA-500-I

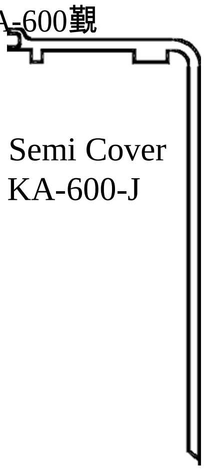
Fig. 8



Bearing Plate KA-500-PJ-B

Fig. 9

KA-600覲



Semi Cover
KA-600-J

Fig. 10

4. Installation

4.1 Installation Dimension

Dimensions of KA-300 glass scale

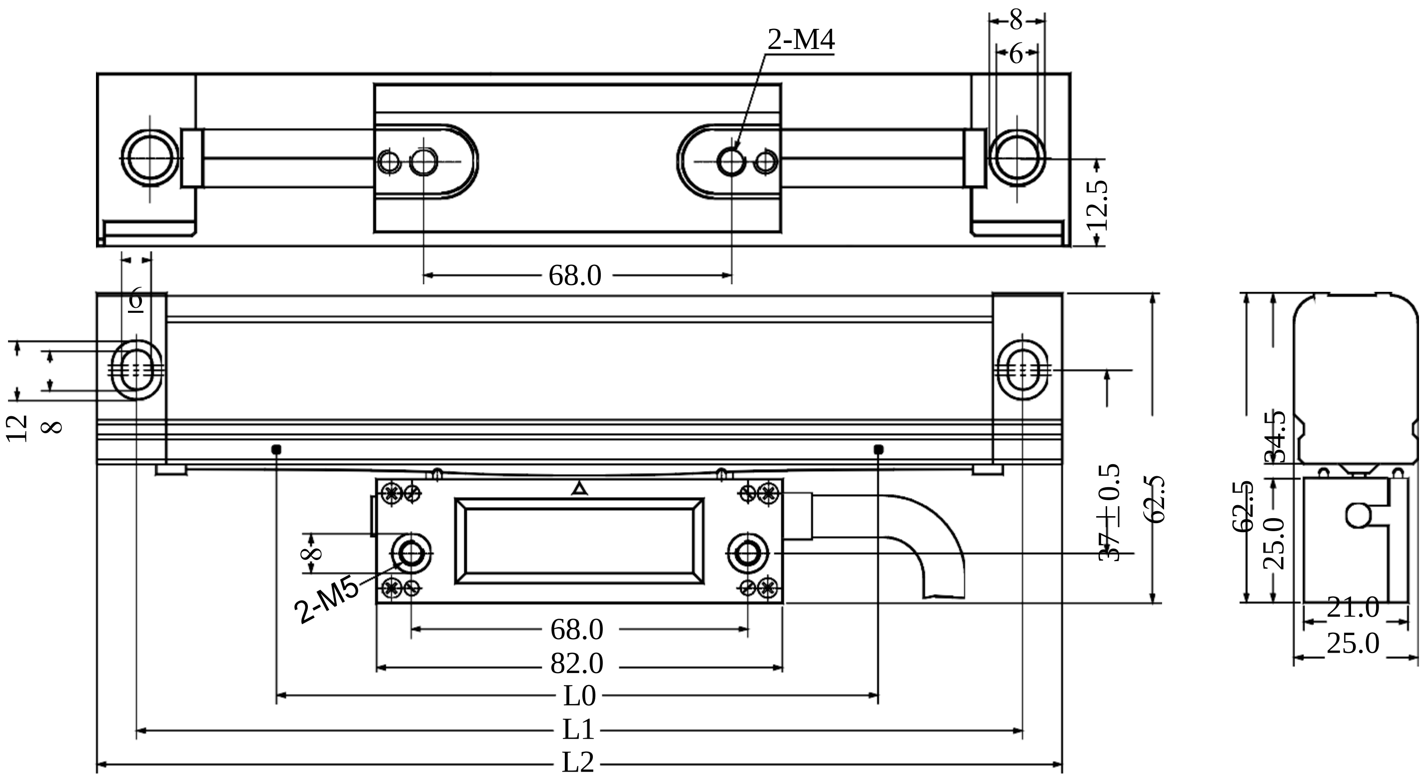


Fig. 11

Model	L0	L1	L2	Model	L0	L1	L2
KA300-70	70	160	176	KA300-570	570	660	676
KA300-120	120	210	226	KA300-620	620	710	726
KA300-170	170	260	276	KA300-670	670	760	776
KA300-220	220	310	326	KA300-720	720	810	826
KA300-270	270	360	376	KA300-770	770	860	876
KA300-320	320	410	426	KA300-820	820	910	926
KA300-370	370	460	476	KA300-870	870	960	976
KA300-420	420	510	526	KA300-920	920	1010	1026
KA300-470	470	560	576	KA300-1020	1020	1110	1126
KA300-520	520	610	626				

Dimensions of KA-500 glass scale

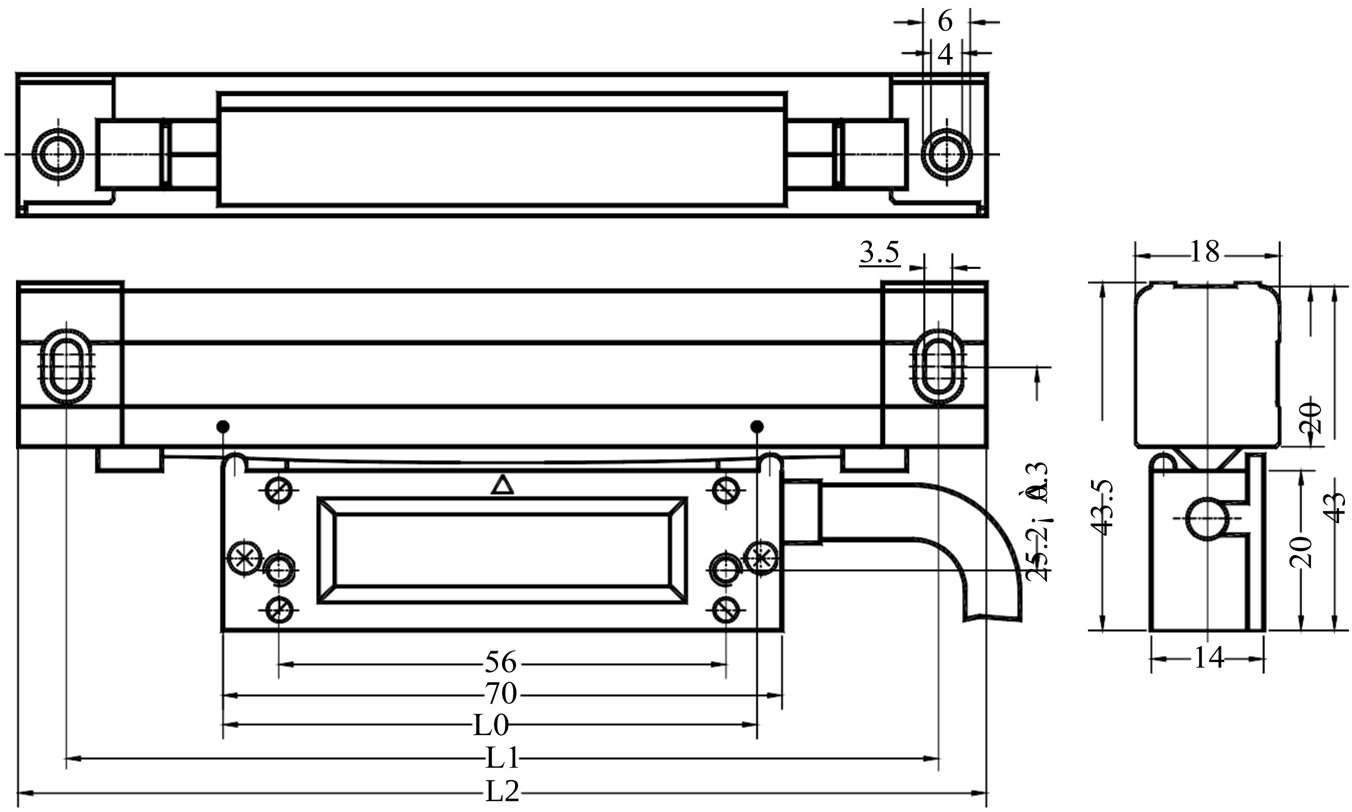


Fig. 12

Model	L0	L1	L2	Model	L0	L1	L2
KA500-70	70	172	182	KA500-320	320	422	432
KA500-120	120	222	232	KA500-370	370	472	482
KA500-170	170	272	282	KA500-420	420	522	532
KA500-220	220	322	332	KA500-470	470	572	582
KA500-270	270	372	382				

Dimensions of KA-600 glass scale.

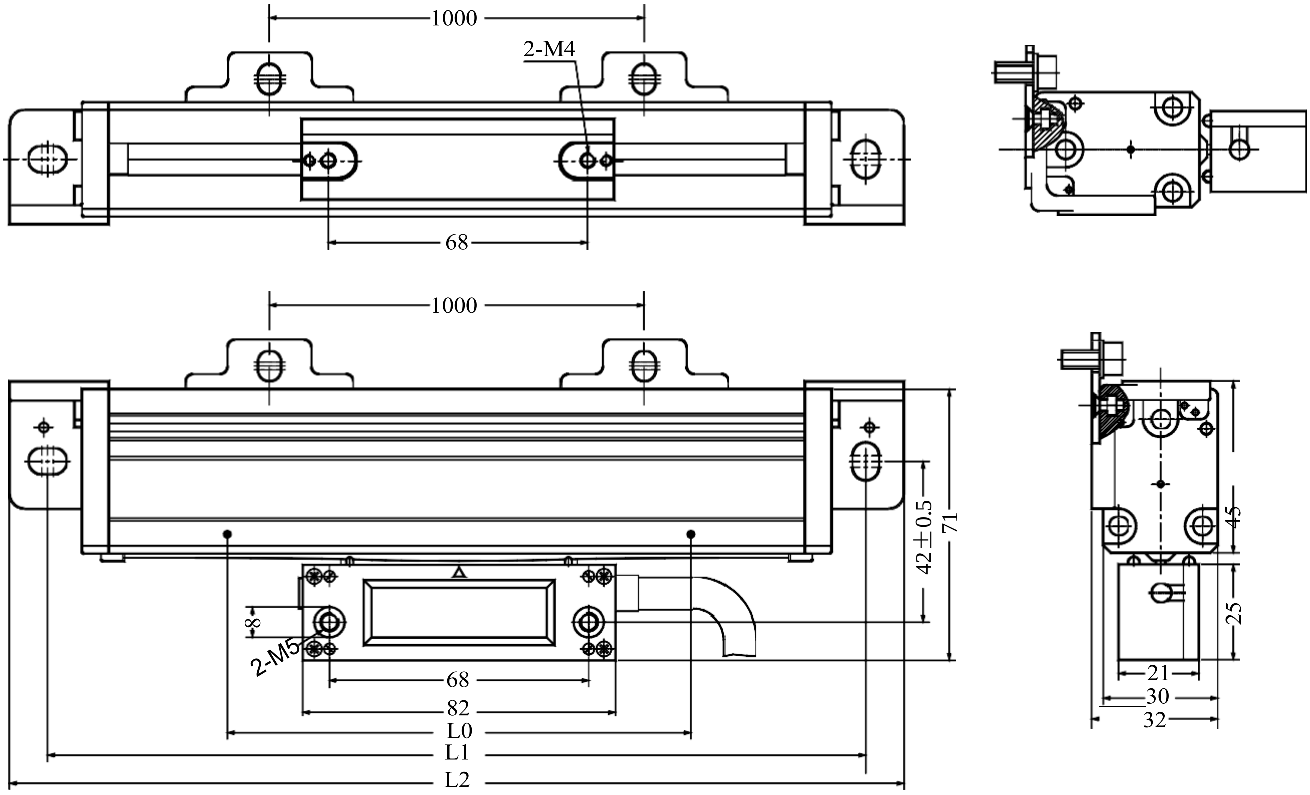


Fig. 13

Model	L0	L1	L2	Model	L0	L1	L2
KA600-1000	1000	1150	1170	KA600-2100	2100	2250	2270
KA600-1100	1100	1250	1270	KA600-2200	2200	2350	2370
KA600-1200	1200	1350	1370	KA600-2300	2300	2450	2470
KA600-1300	1300	1450	1470	KA600-2400	2400	2550	2570
KA600-1400	1400	1550	1570	KA600-2500	2500	2650	2670
KA600-1500	1500	1650	1670	KA600-2600	2600	2750	2770
KA600-1600	1600	1750	1770	KA600-2700	2700	2850	2870
KA600-1700	1700	1850	1870	KA600-2800	2800	2950	2970
KA600-1800	1800	1950	1970	KA600-2900	2900	3050	3070
KA600-1900	1900	2050	2070	KA600-3000	3000	3150	3170
KA600-2000	2000	2150	2170				

L0: Effective metering length

L1: Distance between installation holes

L2: Full scale length

Attentions:

a. The selection of the gauged scale length depends on the travel length of the machine. The gauged scale length must be longer than the maximum travel length of the machine.

b. Proper spare parts shall be adopted according to the given installation length and surface.

c. The KA-600 scale shall be equipped with a hook every 1000mm, i.e. 2 for 1000■L□2000, 3 for 2000■L□3000 and 4 for L = 3000.

4.2 Priorities in Installation

The scale shall use the leading rail of the machine as datumand be installed in parallel to it.

a. The center of the scale range shall be aligned to that of the travel length of the machine and the scale range shall be able to cover the maximum travel length of the machine.

b. The scale shall be installed in the proximity of the transmission screw of the machine. In most cases, the installed scale assembly shall move together with the working platform and the reading head is fixed on the machine.

c. The installed scale shall not obstruct the operation of the machine or compromise the machine's performance.

d. The installed scale shall not be exposed to any impact hazards. During production, the scale shall not stand in the way of machine handles, brakes or other outstanding parts and shall not be touched when loading or unloading work pieces.

e. The scale shall be installed vertically or horizontally as shown in Fig. 14. Never install upside down (with the reading head over the scale assembly). The sealing rubber of the scale assembly must be kept away from the cooling oil nozzle of the machine.

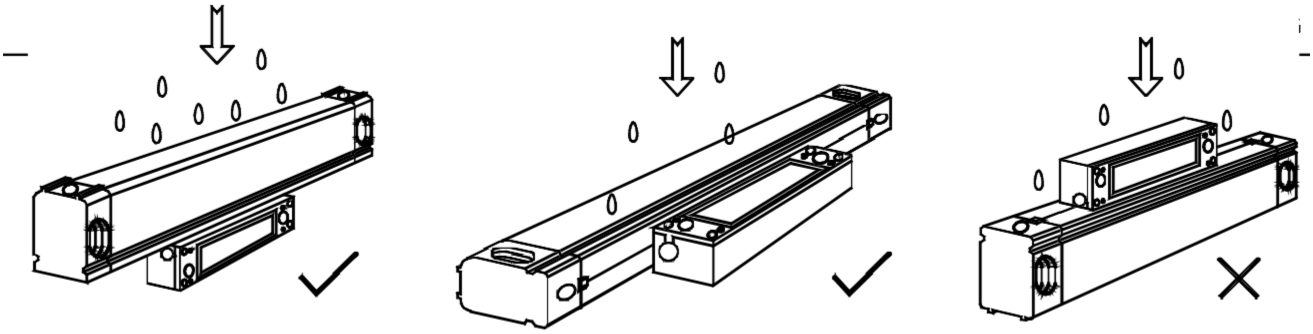


Fig. 14

__4.3__ Installation of the Scale and Scale Cover

(1) Installation of Scales with Cover Type A

a. Choose the proper installation position

b. Mark out and drill M4 screw holes on the installation surface according to the given installation length.

c. Install the scale assembly to the installation surface loosely, check with a micrometer the parallelism of the scale to the machine's leading rail, and adjust the parallelism well. (See Fig. 15)

d. Wrench tight the scale assembly to the installation surface.

e. Adjust the fastening screws of the reading head till they touch the installation surface.

f. Drill M4 screw holes in line with the installation holes of the reading head.

g. Wrench tight the reading head and remove the junction plate.

h. Drill M4 screw holes in line with the installation holes of the scale cover.

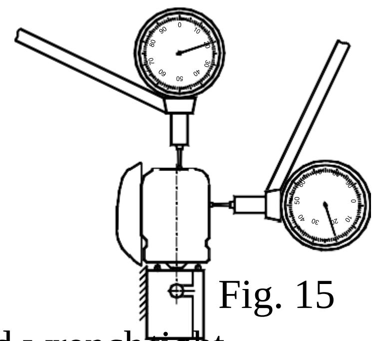
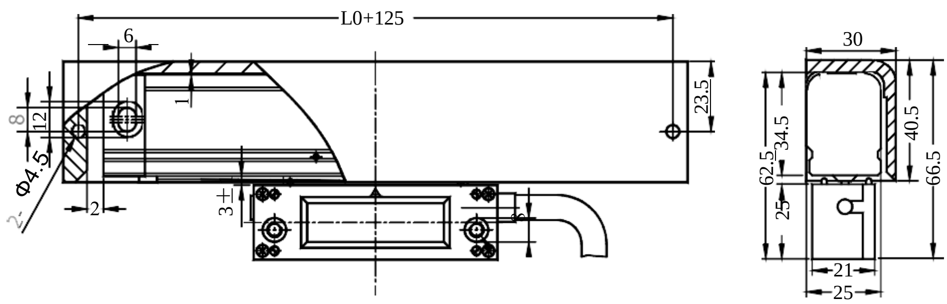


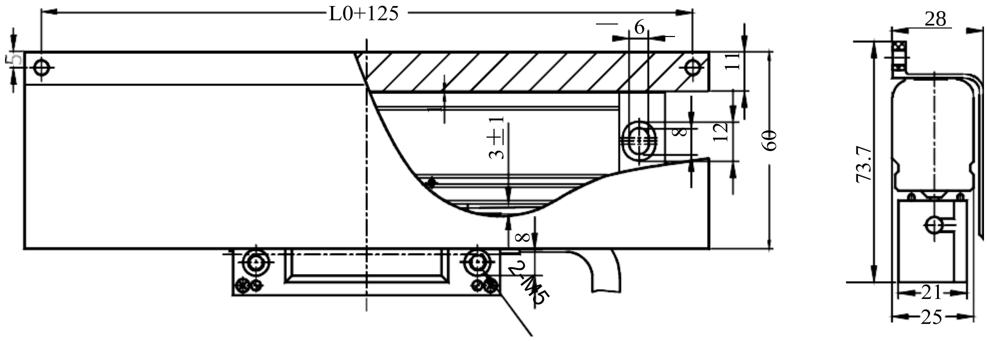
Fig. 15

i. Fix the cover to the installation surface and wrench tight.

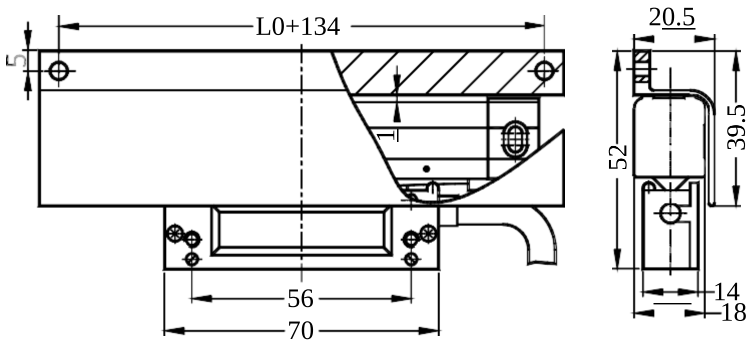


For installation dimensions, see Fig. 17, Fig. 18 and Fig. 19.

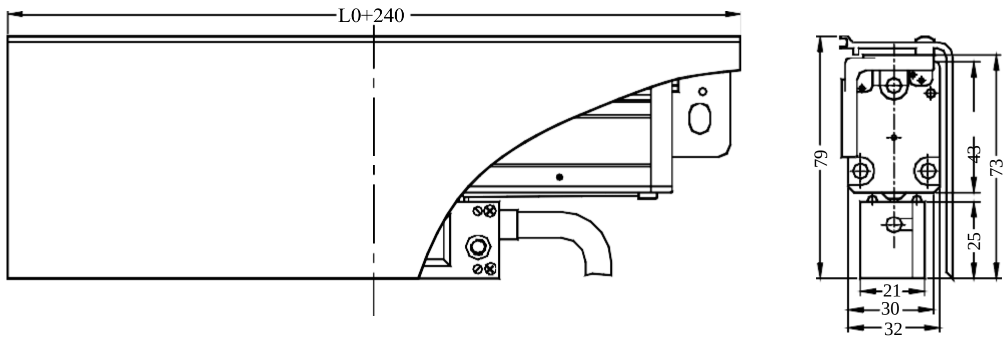
(2) Installation of Scales with Cover Type C, I andJ See Installation of Scales with Cover Type A. Scale with Cover KA-300C:



Scale with CoverKA-500I:



Scale with CoverKA-600J:



For installation dimensions, see Fig. 17, Fig. 18 and Fig. 19.

(3) Installation of Scales with Cover Type B

a. Choose the proper installation position
b. Mark out and drill M4 screw holes on the installation surface according to the installation dimension of scale cover type B.
c. Fix the strengthening plate of the cover to the installation surface loosely, check with a micrometer the parallelism of the

scale to the machine's leading rail, and adjust the parallelism well (See Fig. 16).

d. Wrench tight the strengthening plate to the installation surface.
e. Install the scale assembly to the strengthening plate.
f. Adjust the fastening screws of the reading head till they touch the installation surface.
g. Drill M4 screw holes in line with the installation holes of the reading head.
h. Wrench tight the reading head and remove the junction plate.
i. Drill M4 screw holes in line with the installation holes of the scale cover.

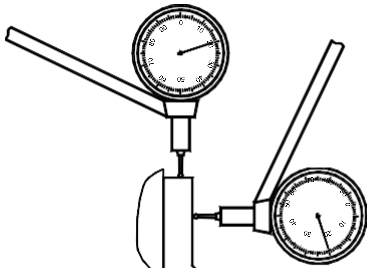
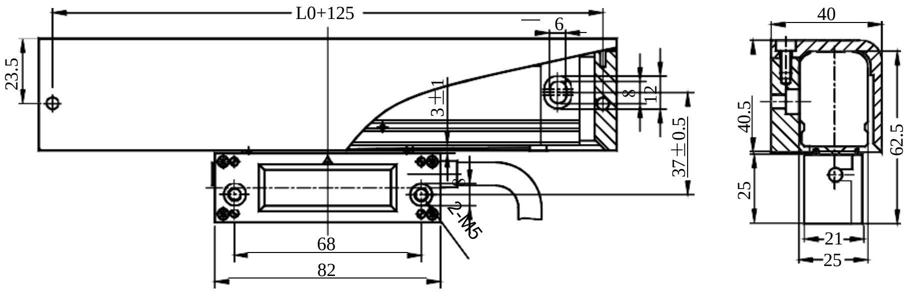


Fig. 16

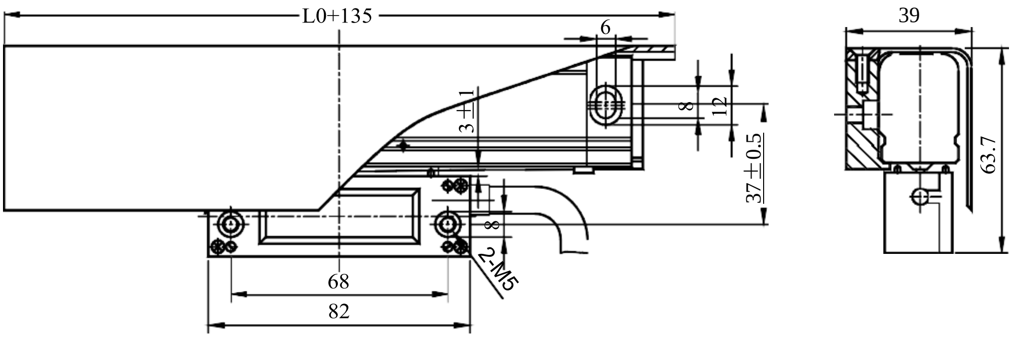
j. Fix the cover to the strengthening plate and wrench tight.



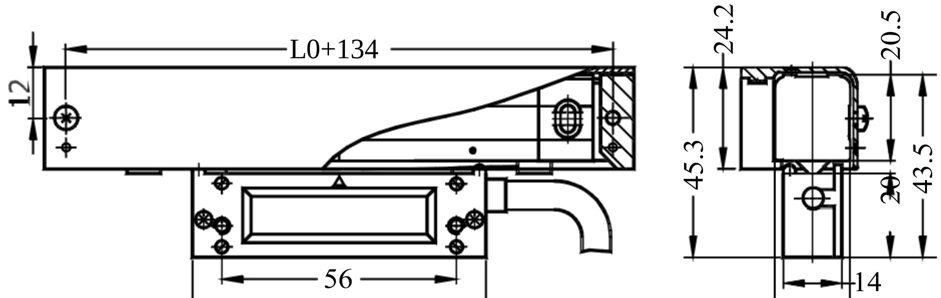
For installation dimensions, see Fig. 17, Fig. 18 and Fig. 19.

(4) Installation of Scales with Cover Type D and G

See Installation of Scales with Cover Type B and H. Scale with Cover KA-300D:



Scale with Cover KA-500G:



For installation dimensions, see Fig. 17, Fig. 18 and Fig. 19.

KA-300觀

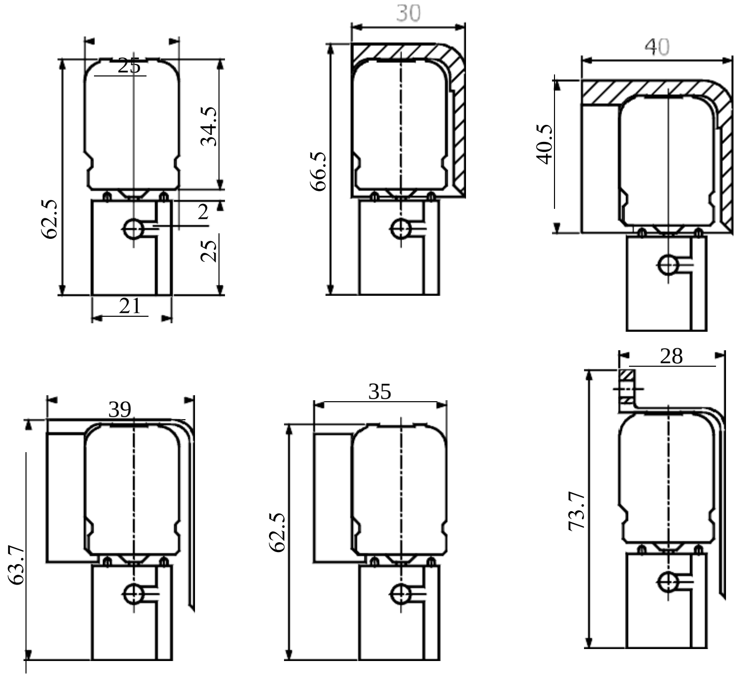


Fig. 17

KA-500:

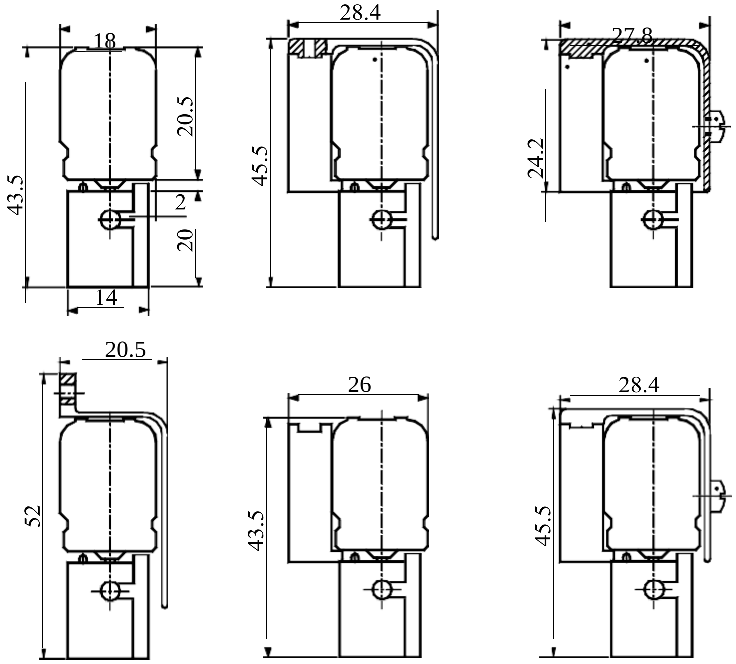


Fig. 18

KA-600觀

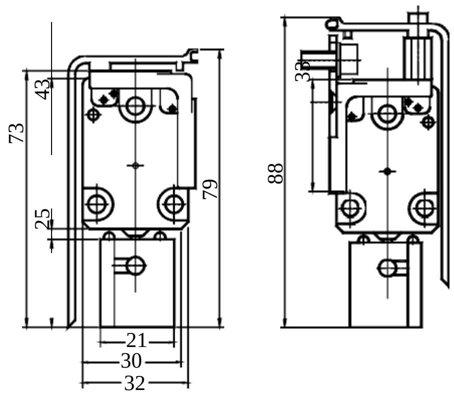


Fig. 19

4.4 Installation of the Reading Head

The reading head can be installed on finished or unfinished surface in a normal or converse way. Only in case of limited installation space, can it be installed conversely.

(1) Normal Installation

Fig. 20 illustrates the normal installation of the reading head. For installation procedure, see Installation of Scale and Scale Cover.

(2) Converse Installation

Fig. 21 illustrates the converse installation of the reading head. The installation procedure is given below:

Note: The following are rather typical installations of the device. The **users may make their own combination and arrangement according to the actual situation.**

a. Fix a T frame (optional) to the machine.

b. Remove the fixed junction plate of the reading head.

c. Adjust the fastening screws of the T frame installation plate till they touch the reading head.

d. Fix the reading head with M5 screws to the T frame installation plate.

e. Adjust the T frame plates till the relative position of the reading head to the scale assembly is as shown in Fig21.

f. Install the scale by making use of the T frame (See Fig. 22 – Fig. 31. A: Plate A of T frame; B: Plate B of T frame; C: Extension plate C of T frame; D: Extension plate D of T frame; and E: Part E of T frame).

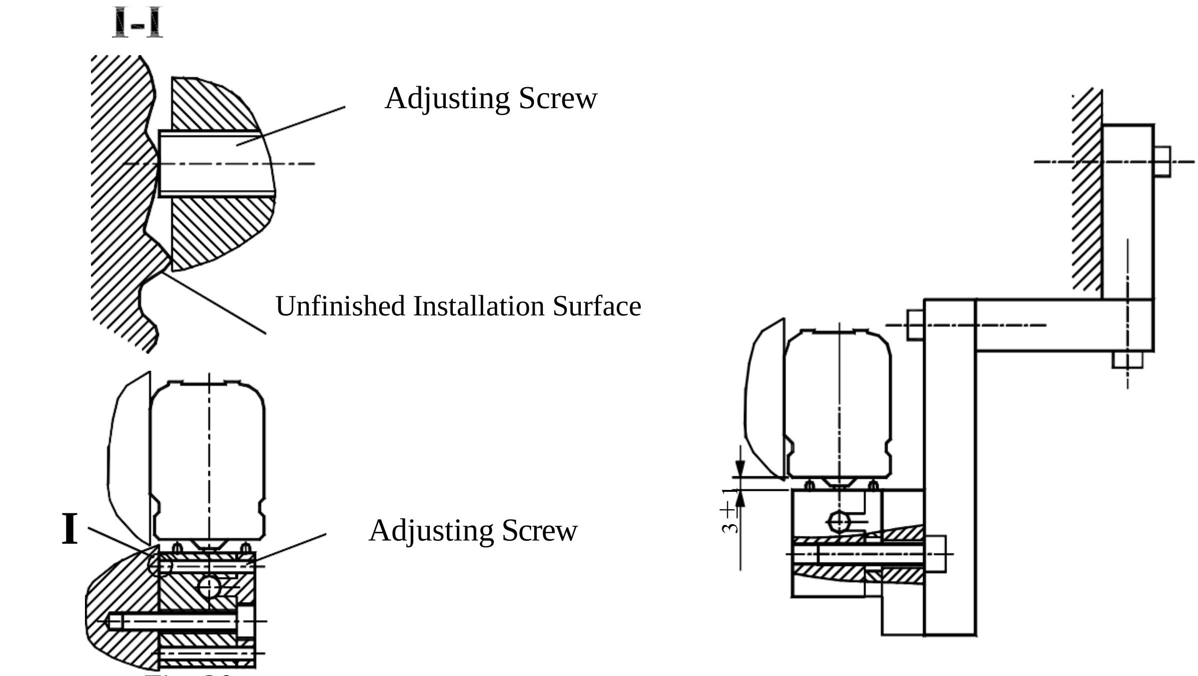


Fig. 20

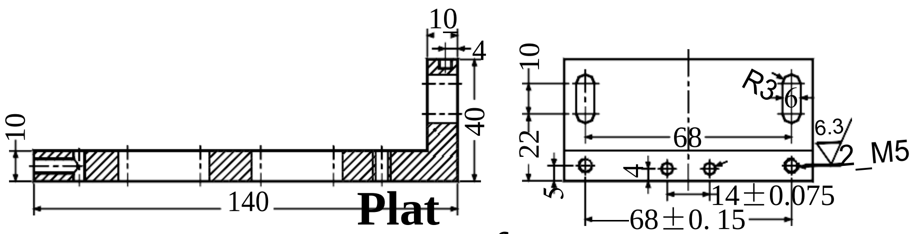


Plate of T Frame

A

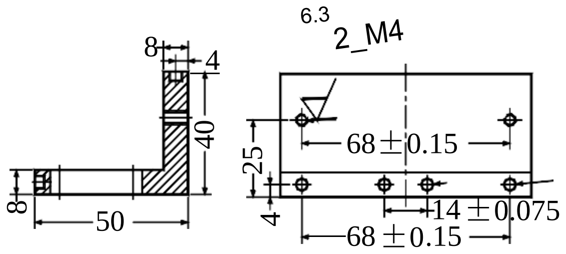
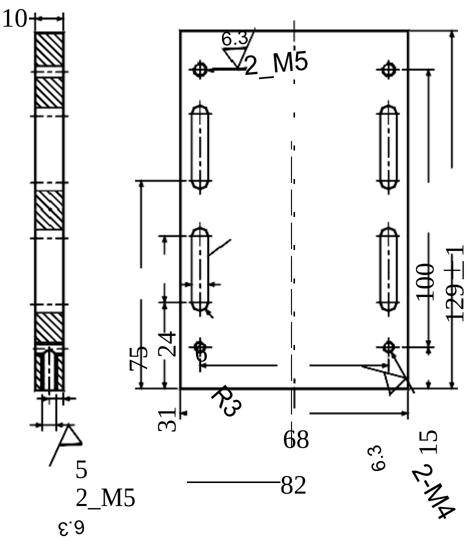
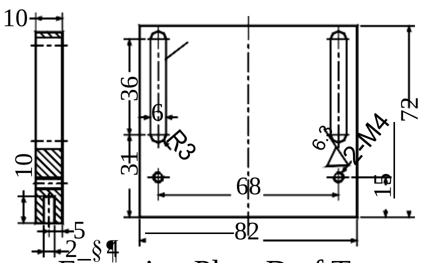


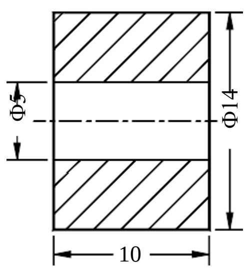
Plate B of T Frame



Extension Plate C of T Frame



Extension Plate D of T Frame



Part E of T Frame

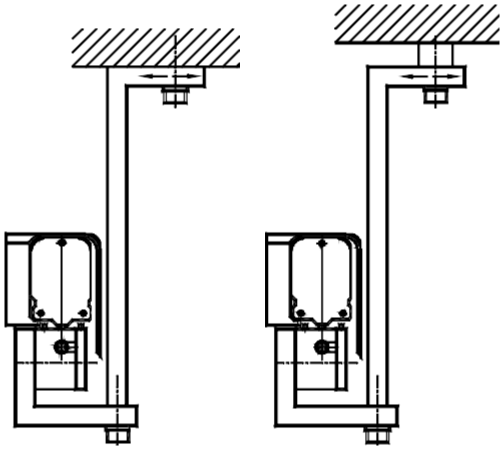


Fig. 22

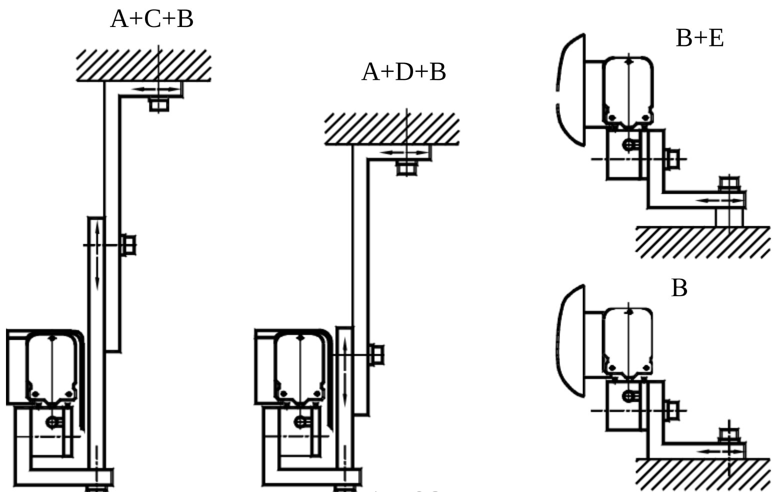


Fig. 23

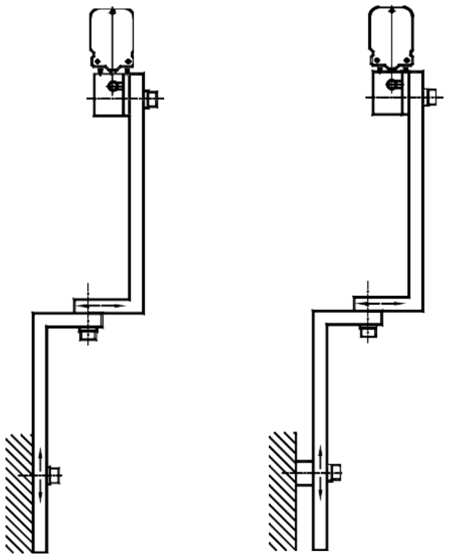


Fig. 24

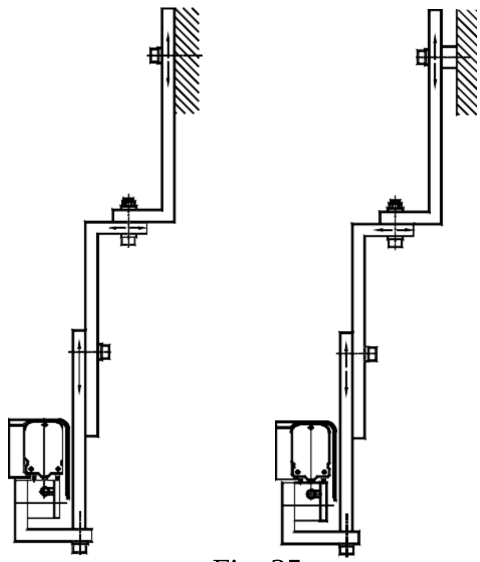


Fig. 25

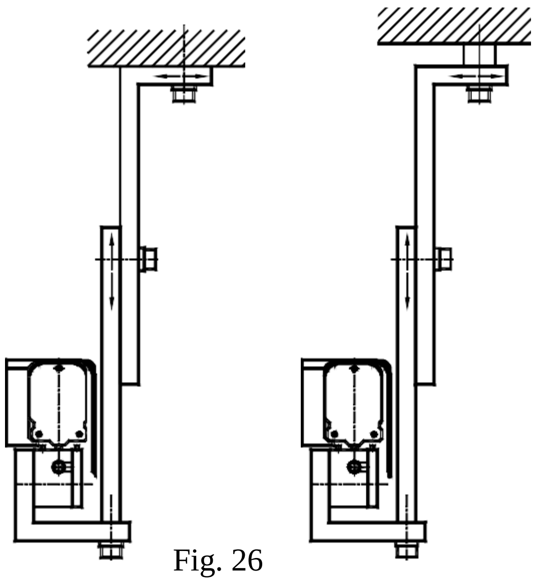


Fig. 26

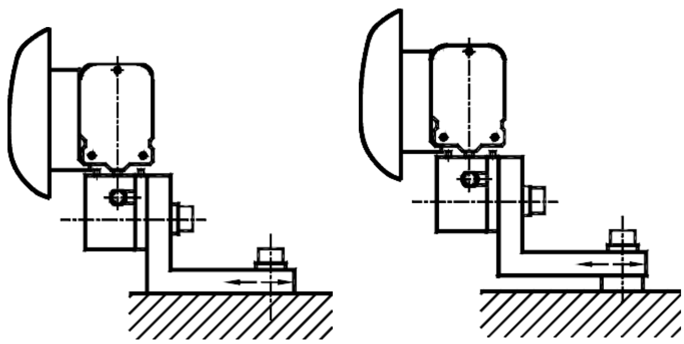


Fig. 27

Figures above applicable to installation of KA-300 and KA-600scales

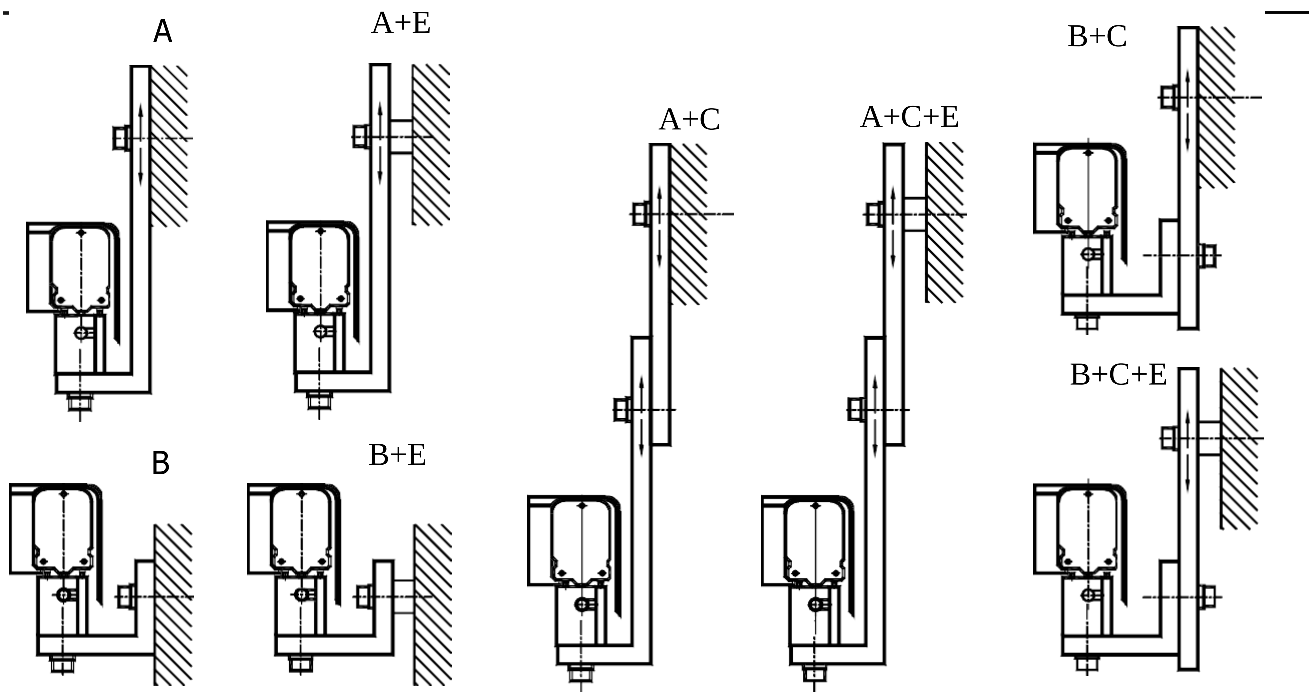


Fig. 28

Figures above applicable to installation of KA-300 and KA-600scales

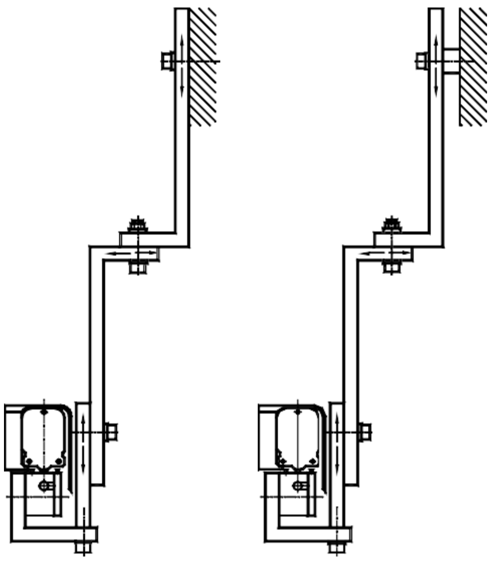


Fig. 29

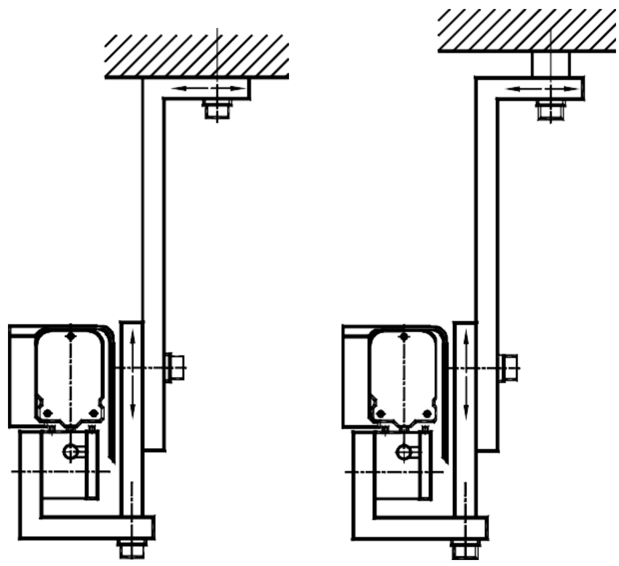


Fig. 30

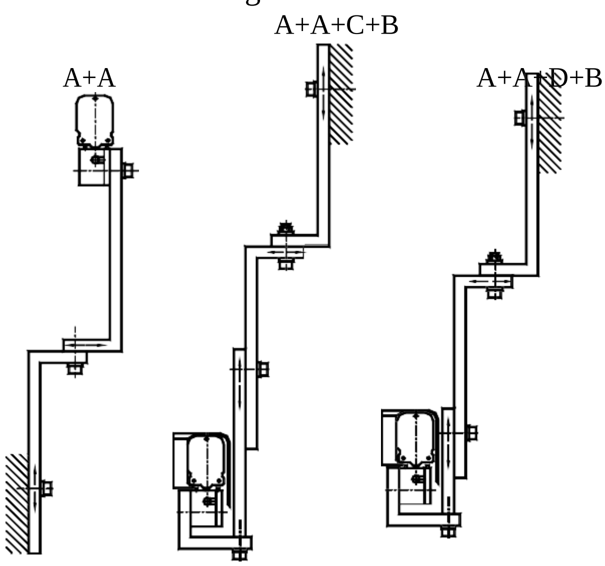


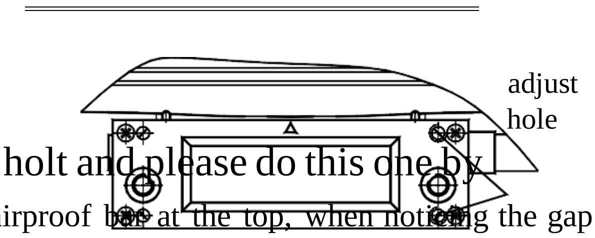
Fig. 31

Figures above applicable to installation of KA-300 and KA-600scales

4.5 Rearrangement of Reading Head Cable

The cable of the reading head is arranged on the right in the factory. If it is inconvenient for use, the user may rearrange it in another direction in the following procedure:

(1) Take out four M2 “+” setscrew in the figure cover and two M3 “-” bolt on the right of the cover.



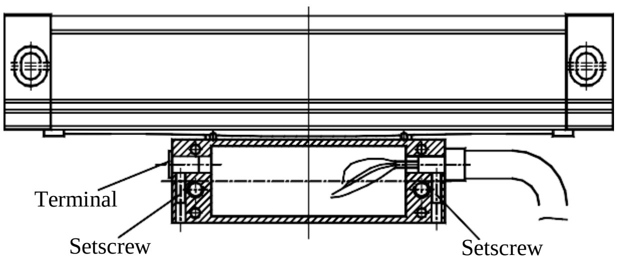
(2) M4 hex bolt into the adjust screw holt and please do this one by one for flab the cover board which has airproof bar at the top, when noticing the gap. Please pry the cover board along the top by the screwdriver.

(3) Loose two M3 ”-” bolt of the moor cable, remove the cable and end. Exchange the orientation.

(4) Before covering the cover board, you must clean the old airproof bar and wipe the new one, if do not have the new one, you can use butter order to instead of that, but the effect is not so good, only in support.

(5) Take out of six M4 hex bolt, screw down the setscrew, fit on the cover board and the cover board bolt and adjust bolt.

Note: The tools used in taking down in each step is partnership, avoiding the screw head sleeking.



5. Checking installation

5.1 With the reading head securely fastened, if you shake it headlong, position display may fluctuate while shaking, but will always return to the same stable value if left alone.

5.2 The reading head should be centered in the scale body to ensure proper sealing as shown in Fig32, Fig 33 and Fig 34.

KA-300:

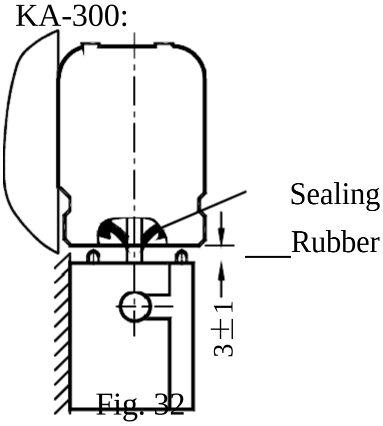
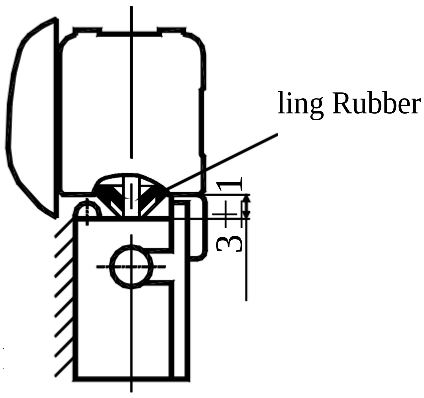


Fig. 32

KA-500:



KA-600:

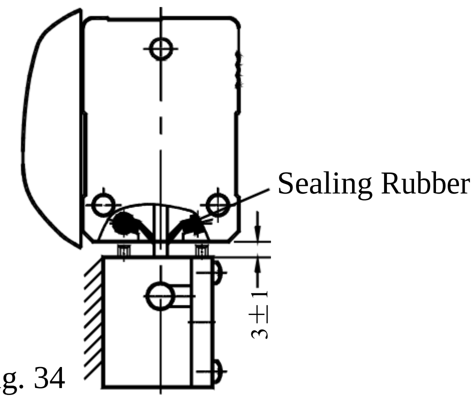


Fig. 34

Sterling

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Appendix B

TENSILE TEST MACHINE
USER MANUAL

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Project supervisor
Dr.Husain Amro

Dec2018،Hebron

الفهرس

تعريف الاستخدام

صممت هده الماكينة لإجراء فحص اختبار الشد بصوره محوسبه وبدقه عالية على المعادن حيث يتم فيه تسليط حمل شد متزايد على العينة التي تم تحضيرها مسبقا بناء على مواصفات قياسيه معينه ، ودلك تثبيت طرفيها بمعدات خاصه وتسليط الحمل بشكل محوري وبصوره متعاكسة ، وبدلك يزداد طول العينة نتيجة لهدا الشد او السحب .

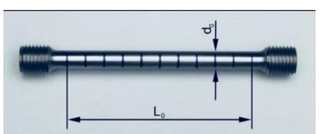
ان اختبار الشد والانضغاط هي اكتر الاختبارات شيوعا وبساطه ، والمعلومات التي يتم الحصول عليها من هده الاختبارات دات اهميه خاصه للمصمم . وفي كثير من الاحيان تجري الاختبارات على المواد المصنعة بحجمها الكامل بنفس الصيغ المتبعة في اختبار العينات، ومثال على دالك الاختبارات التي يتم اجراءها على اطوال معينه من الاسلاك و القضبان والانابيب والحبال السلكية وغيرها

تنبيه !!

قبل القيام باستخدام الماكينة يجب قراءه التنبيهات التالية

❖ التوصيل الكهربائي

يجب توصيل الماكينة الى مصدر الكهرباء فقط عن طريق مقبس مزودة بوصله تأريض وفقا للوائح المعمول بها ، ينص القانون على ضرورة توصيل الماكينة بالأرض.



❖ تحضير عينه الاختبار

يلزم اختيار القطعة المراد الفحص عليها من المعادن وأخذ القياسات من { طول ، والقطر } لإدخالها على البرنامج.

❖

❖ سلامه عمل الماكينة

قبل اجراء الفحص يجب التأكد من مستوى الزيت وتوصيل الاسلاك وصحه ربطها مع جهاز الكمبيوتر.

❖ مكان الاختبار

التأكد من ابتعاد اي جزء كهربائي او ميكانيكي من منطقه اجراء الاختبار وتأثير القوى.

❖ حدود حركه البستون

هناك سهم احمر على غطاء البستون والذي لا يجب ان يتجاوز العلامات الموضوعة كما هو موضح في الشكل التالي

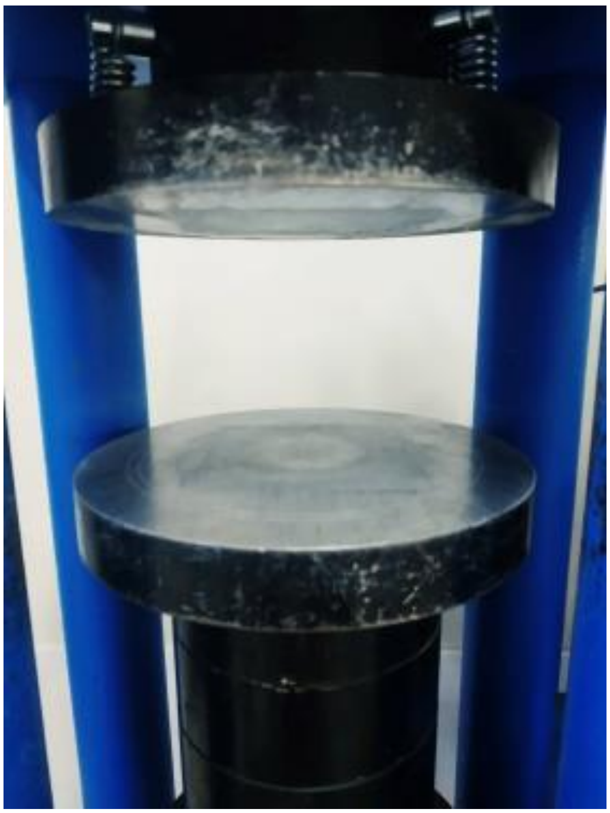
❖ قواعد الاختبار

بالبدايه نذكر باختيار قواعد الاختبار المختار لتثبيت القطعه المراد اجراء الاختبار عليها نرفق لكم صور توضح قواعد الاختبارات :

- قواعد اختبار الشد

- قواعد اختبار الضغط

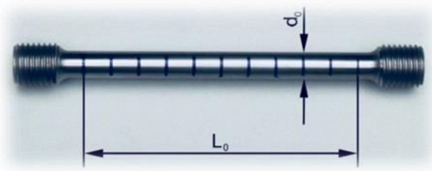
قواعد اختبار الشد



قواعد اختبار الضغط

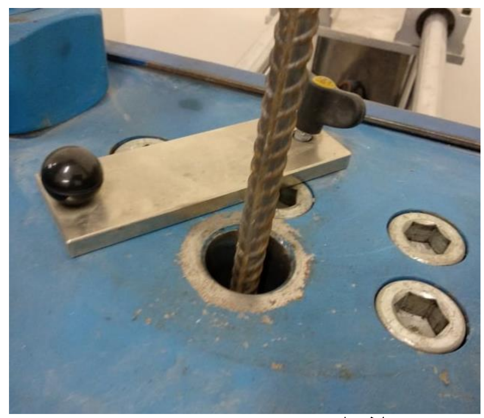
طريقه اجراء الاختبار

الجزء الاول : اجراء اختبار الشد

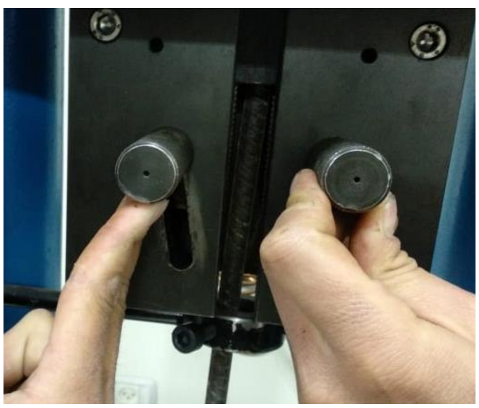


- قم باختيار القطعة المراد اجراء الاختبار عليها
- اخد القياسات والابعاد للقطعة مثل { طول ، قطر } اللازمة لأجراء الاختبار
- طريقه تثبيت القطعة :

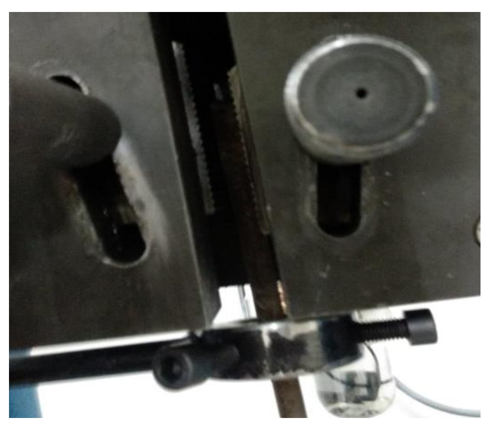
نقوم بإدخال قطعة الاختبار من الاعلى كما في الشكل (1)، ومن ثم نعمل على ادخالها وتمريرها من خلال لقم التثبيت وحلقة التثبيت المرتبطة بحساس قياس الطول كما في الأشكال (2+3+4+5)، ومن ثم نعمل على شد لقم التثبيت وشد حلقات التثبيت لتصبح كما في الشكل (6)، ومن ثم يتم اقفال الباب لضمان الحماية.



الشكل (1)



الشكل (2)



الشكل (3)

الشكل (4)

الشكل (5)

الشكل (6)

الشكل (7)

الشكل (8)

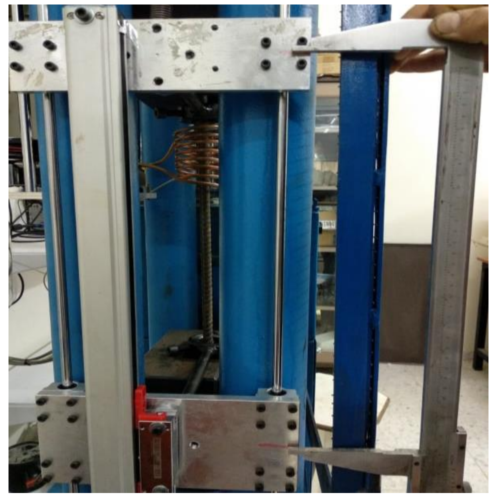
- **بعد ان تم تثبيت قطعة الاختبار قبل اجراء الاختبار يجب اتباع الاجراءات التالية:**

1- **اخذ طول قطعة الاختبار بعد التثبيت حسب الخطوط الحمراء وكما هو موضح بالشكل (1.1)**

2- **التأكد من ان مفتاح المحرك بالاتجاه الموضح بالشكل (2.1)**

3- **التأكد من أن مؤشر الضغط مثبت على (6mm/s) كما في الشكل (3.1)**

4- **التأكد من أن مفتاح اختيار الاختبار متجه على إختيار الشد وكما هو موضح بالشكل (4.1)**



الشكل (1.1)

الشكل (2.1)

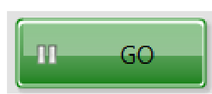
الشكل (3.1)

الشكل (4.1)

تشغيل البرنامج الخاص بالماكينة

- **برنامج ماكينة اختبار الشد والضغط**

1. نقوم باختيار نوع الاختبار من الايقونة كما هو موضح في الشكل التالي 

ثم نضغط بعد ذلك على الامر 

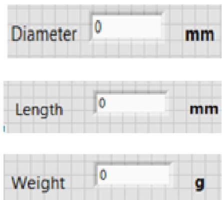
للإنتقال إلى صفحة إدخال البيانات

2. صفحه ادخال البيانات

نقوم بإدخال الابعاد والقياسات التي تم اخذها من قطعه الاختبار في صفحه البيانات كما هو موضح بالشكل التالي، بالإضافة الى تشغيل او ايقاف عمل المضحة، نظام الحرارة او نظام الانذار.

➢ أهم البيانات التي يجب ادخالها :

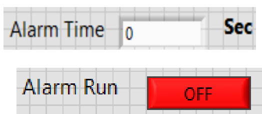
- {Diameter} قطر قطعه الاختبار
- {length} طول قطعه الاختبار
- {weight} وزن قطعه الاختبار



➢ نظام الانذار(Alarm system)

بعد تشغيل نظام الانذار يمكنك تحديد الوقت اللازم لاجراء الاختبار حيث بعد انتهاء الوقت يتم تفعيل جهاز الانذار لتنبيه الفاحص بانتهاء الاختبار.

- ادخال قيم وقت الانذار
- تشغيل الانذار

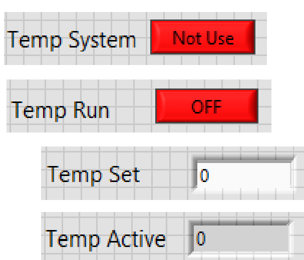


➢ المضخة الهيدروليكية (Hydraulic pump)

- الايقونة الخاصة بالمضخة الهيدرولويكية والتي منها يتم تشغيل وإيقاف المضخة

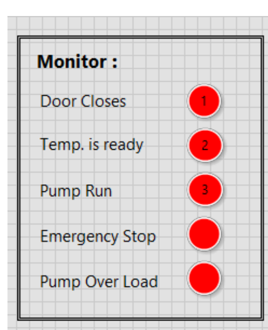
➢ نظام الحرارة (Temperature system)

- الايقونة الخاصة بالحرارة والتي منها يتم تفعيل او الغاء تفعيل الحرارة
- الايقونة الخاصة بالحرارة والتي منها يتم تشغيل وإيقاف الحرارة
- ادخال قيمة درجة الحرارة
- قراءة قيمة درجة الحرارة

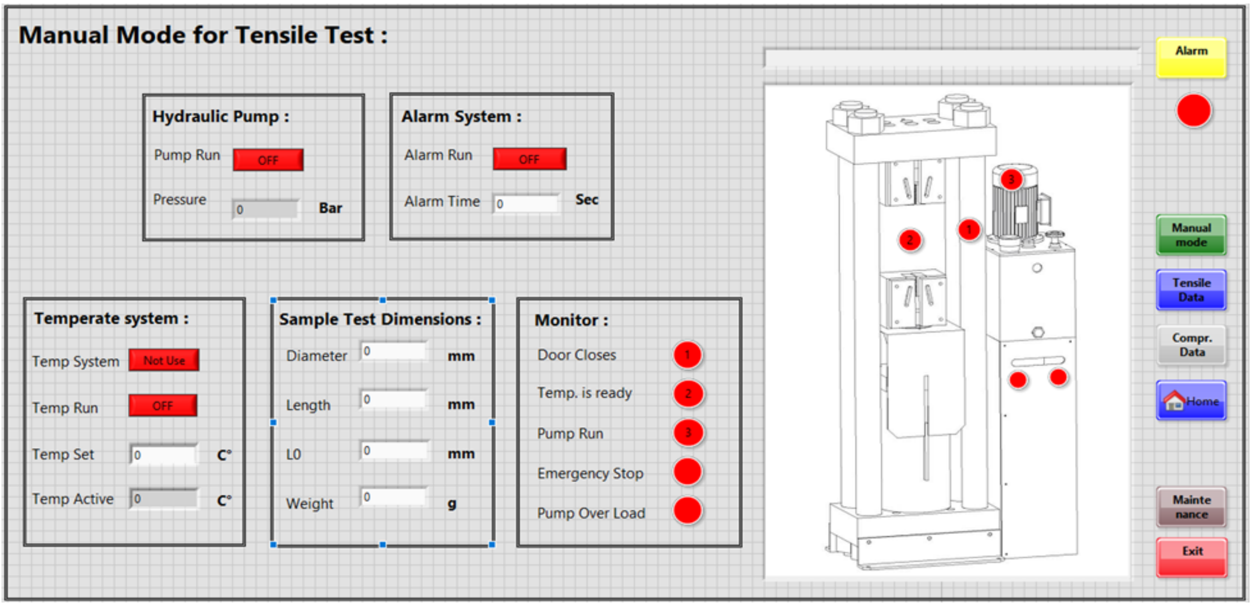


➢ شاشة المراقبة (Monitor)

وتستخدم لإظهار الاجزاء المفعلة وغير المفعلة بالنظام



➢صورة عامة لصفحة ادخال البيانات

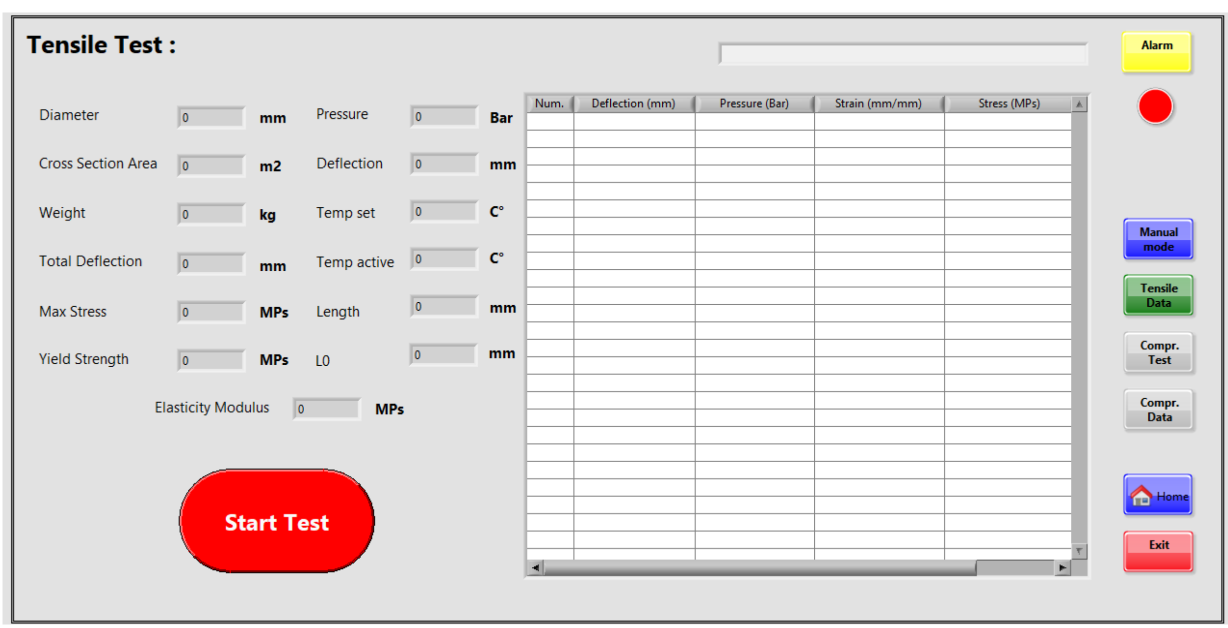


3. صفحه اختبار الشد

بعد اختيار السرعة المناسبة للمضحة (6 mm/s) واختيار نوع الاختبار والانتهاء من تعبئة البيانات المطلوبة نقوم بالضغط على أيقونة (start test) ونلاحظ قراءات الاختبار بالجدول المرفق بالشكل التالي وعند حدوث القطع نقوم بالضغط على أيقونة (exit) علما انه بعد الضغط عليها يتم نقل البيانات تلقائيا الى ملف Excel لرسم المنحنى الخاص بالاختبار.

الجدول يظهر به قيم وقراءات الاختبار ، والخانات الاخرى هي للقراءة فقط لإظهار القيم حسب اسمها.

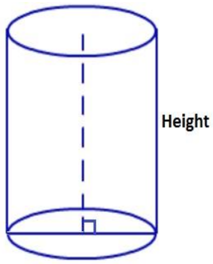
➢صورة عامة لصفحة اختبار الشد



الجزء الثاني : اختبار الضغط

- قم باختيار القطعة المراد اجراء الاختبار عليها
- اخد القياسات والابعاد للقطعة مثل { طول ، قطر } اللازمة لأجراء الاختبار
- طريقه تثبيت القطعة :

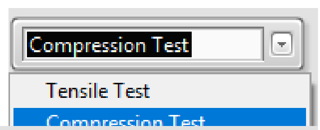
نقوم بوضع القطعة وتثبيتها جيدا بالماكينة في المكان الصحيح كما هو موضح بالشكل واغلاق البوابة بأحكام عليها



- نقوم بتشغيل البرنامج الخاص بالماكينة

- برنامج ماكينة اختبار الشد والضغط

1. نقوم باختيار نوع الاختبار من الايقونة كما هو موضح في الشكل التالي



2. صفحه ادخال البيانات

نقوم بإدخال الابعاد والقياسات كما في اختبار الشد و التي تم اخذها من قطعه الاختبار في صفحه البيانات كما هو موضح بالشكل التالي، بالإضافة الى تشغيل او ايقاف عمل المضخة، نظام الحرارة او نظام الانذار.

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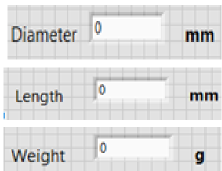

- {Diameter} قطر قطعه الاختبار
- {length} طول قطعه الاختبار
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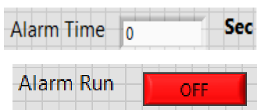


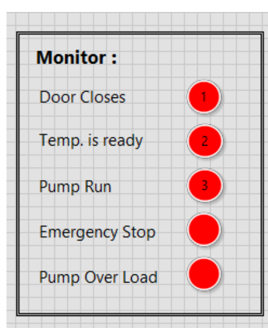
- ادخال قيم وقت الانذار
- تشغيل الانذار

➢ المضخة الهيدروليكية (Hydraulic pump)

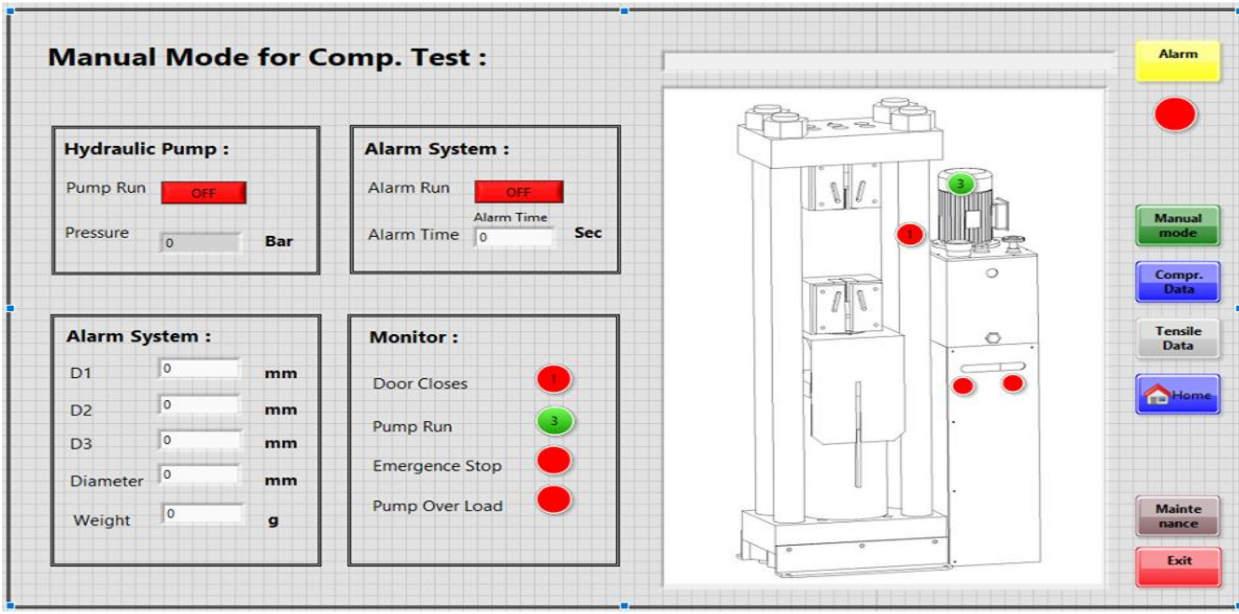
▪ الايقونة الخاصة بالمضخة الهيدروليكية والتي منها يتم تشغيل وإيقاف المضخة

➢ شاشة المراقبة (Monitor)

وتستخدم لإظهار الاجزاء المفعلة وغير المفعلة بالنظام

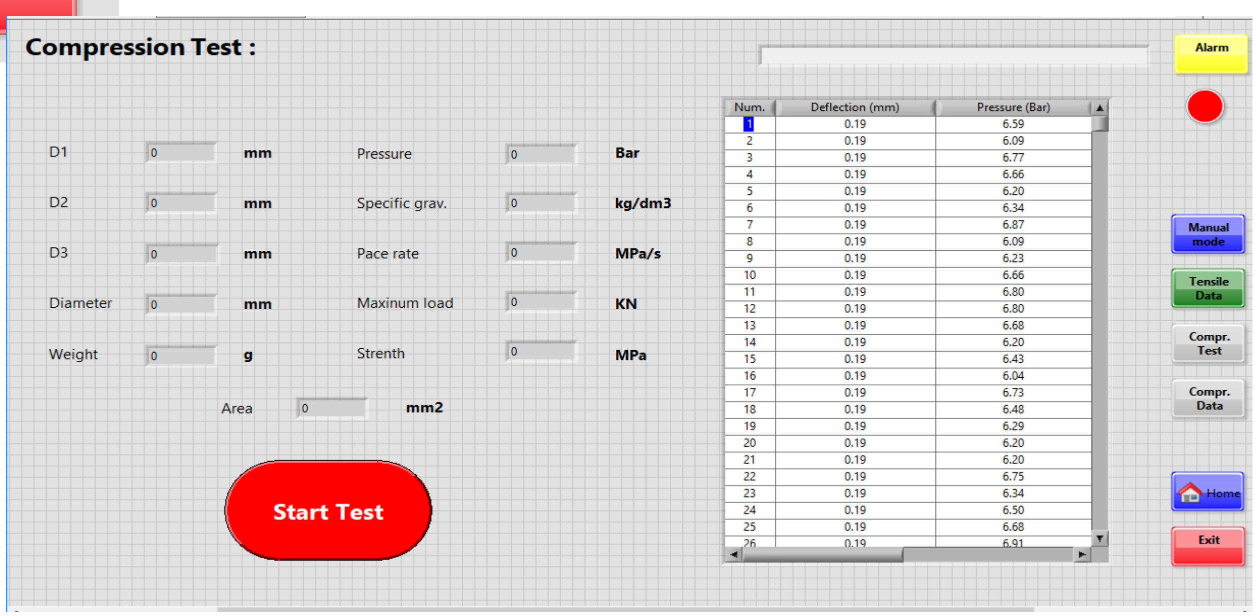


➢صورة عامة لصفحة ادخال البيانات



4- صفحه اختبار الضغط

بعد اختيار السرعه المناسبة للمضحة (6 mm/s) واختيار نوع الاختبار والانتهاء من تعبئة البيانات المطلوبة نقوم بالضغط على ايقونه (Start test) ونلاحظ قراءات الاختبار بالجدول المرفق بالشكل التالي وعند حدوث القطع نقوم بالطغط على ايقونه (Exit) علما انه بعد الضغط عليها يتم نقل البيانات تلقائيا الى ملف Excel لرسم المنحنى الخاص بالاختبار.



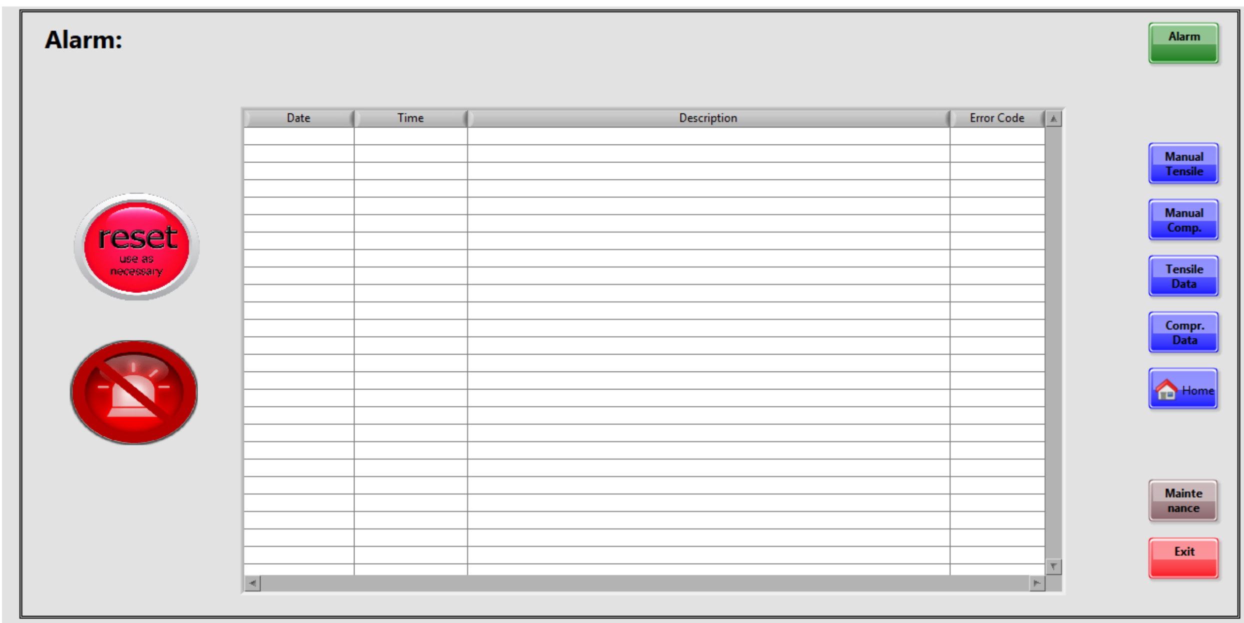
5- صفحة الاخطاء

هي الصفحة التي يظهر بهاء جميع الاخطاء التي قد تظهر خلال الاختبار من خلال جدول على النحو التالي:

- Date تاريخ ظهور الخطأ.
- Time وقت ظهور الخطأ.
- Description توضيح الخلل و وصفه.
- Error Code رقم الخطأ

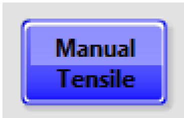
- الضاغط Reset يستخدم بهدف افراغ الجدول من الاخطاء بعد حلها

- الضاغط المقابل يستخدم لإيقاف تشغيل الانذار

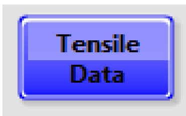


6- التنقل بين الصفحات

للتنقل بين الصفحات نستخدم الازرار الموجودة على اقصى يمين الشاشة

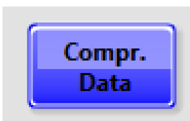


1- للانتقال إلى الصفحة الخاصة بإدخال البيانات في اختبار الشد

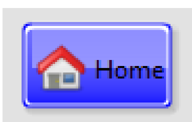


2- للانتقال إلى صفحة اختبار الشد

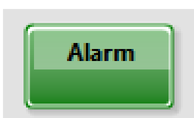
3- للانتقال إلى الصفحة الخاصة بإدخال البيانات في اختبار الضغط



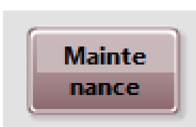
4- للانتقال إلى صفحة اختبار الضغط



5- للرجوع إلى الصفحة الرئيسية



6- للذهاب إلى صفحة الاعطال



7- للانتقال إلى صفحة الصيانة

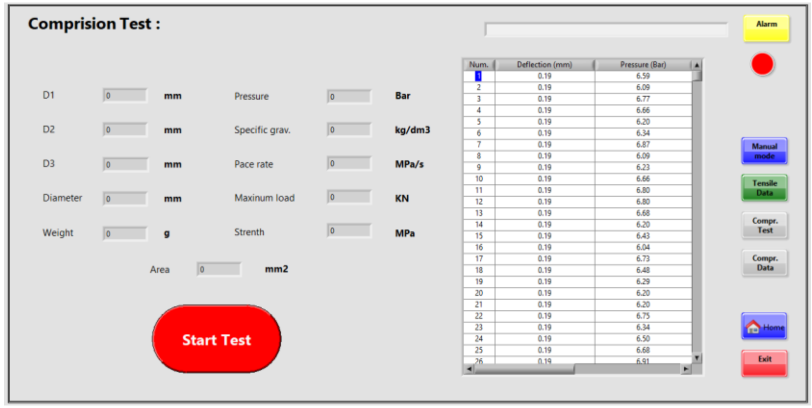
8- للخروج من البرنامج وحفظ البيانات

❖ حفظ البيانات على مايكروسفت اكسل

بعد تشغيل الاختبار من أيقونة البدء يجب الضغط
على أيقونة exit لتتمكن من حفظ البيانات على ملف اكسل

أيقونة البدء

أيقونة الانهاء وحفظ البيانات



❖ صمام التحكم بسرعه تدفق الزيت

يتم التحكم بسرعه التدفق الزيت التي تساعدنا على تحريك
البستون للأعلى او للأسفل
علما ان السرعة المناسبة للاختبار 6 mm/s

❖ بوابه الحماية

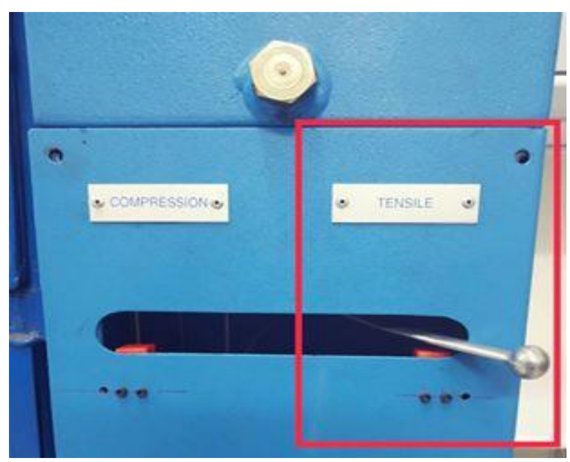
يجب التأكد من اغلاق بوابه الحماية بأحكام
بعد تثبيت القطعة بشكل صحيح

❖ مفتاح تحديد نوع الاختبار

يجب توجيه مفتاح الاختبار باتجاه الاختبار المطلوب كما هو موضح بالشكل التالي

- اختبار الشد (Tensile) اقوم بتحرك المفتاح باتجاه اليمين من الماكينة
- اختبار الضغط (compression) اقوم بتحرك المفتاح باتجاه اليسرى من الماكينة

Compression Mode



Tensile Mode

دليل تحري الاعطال

تتميز الماكينه بوظائف أمان أوتوماتيكية مختلفة. هذه الوظائف تساعد على اكتشاف الأعطال في الوقت المناسب، ويمكن لنظام السلامة أن يستجيب بالطريقة المناسبة. هذه الأخطاء بسيطة جدا ويمكن اصلاحها خلال بضع دقائق

المشكله	الاسباب ، الحلول ، النصائح
5540: Incorrect tensile position	مفتاح تحديد نوع الاختبار ليس بالمكان الصحيح ويجب وضعه على tensile
5541: Door in not closed	بوابه الامان مفتوحه ويجب اغلاقها باحكام قبل البدء بالاختبار
5542: Emergency key is enabling	مفتاح الطوارئ فعال يجب الغاء تفعيله لبدء عمل الاختبار
5543: Over load on the pump	المضخه الهيدروليكيه تتعرض لحمل زائد ويجب ايقافها فورا
5544: Incorrect comp. position	مفتاح تحديد نوع الاختبار ليس بالمكان الصحيح ويجب وضعه على compression
5545: The temp. out of range	درجه الحراره تجاوزت القيمه المضبوطه على البرنامج ويجب اتباع اجراءات اللازمه
5546: The piston on top dead center	البستون في منطقه النقطه الميته العليا
5547: The piston on bottom dead center	البستون في منطقه النقطعه الميته العليا
5555: The pressure is very high	الضغط الهيدروليكي تجاوز الحد المسموح به وبعدها يتم توقيف عمل الماكينه

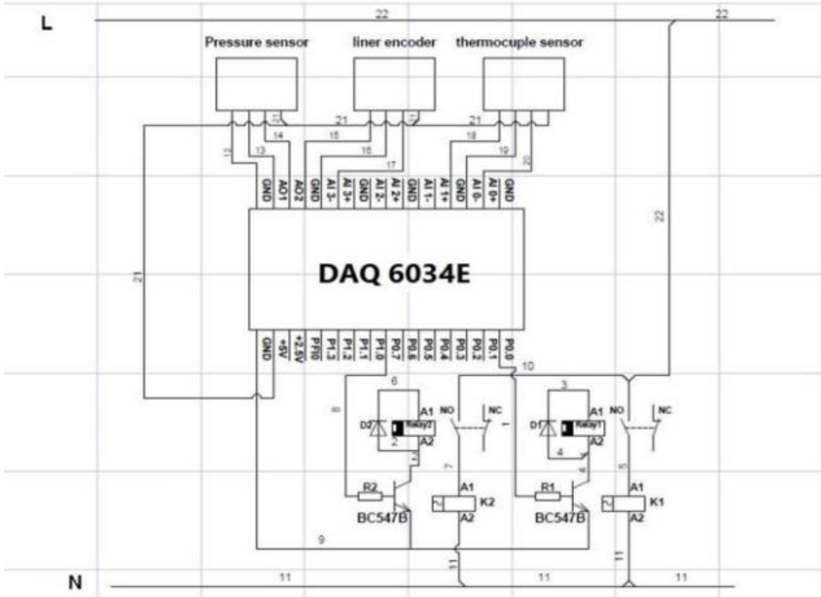
التوصيلات الكهربائية

لتوصيل حساس قياس الاستطال يتم توصيلها بالتالي  كما يظهر بالشكل رقم (1.2)

الشكل (1.2)

❖ توصيل الاسلاك بالمتحكم

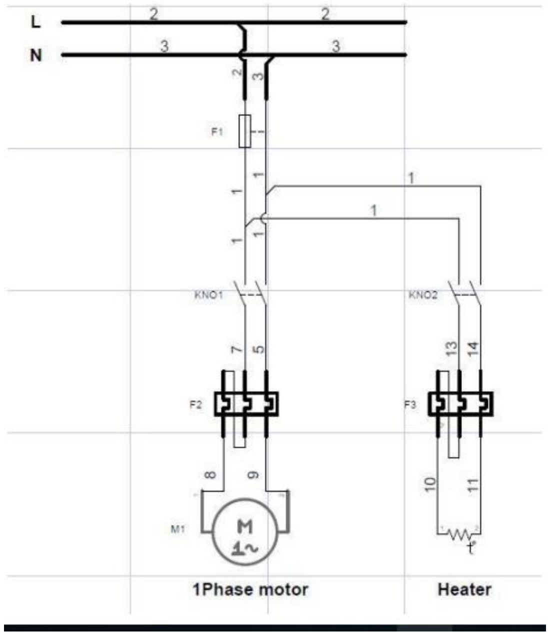
الشكل (1.3) يمثل توصيل الحساسات والكنتاكتر بالمتحكم NI DAQ 6034E وهي بذلك تمثل دائرة التحكم في الماكينة .



الشكل (1.3)

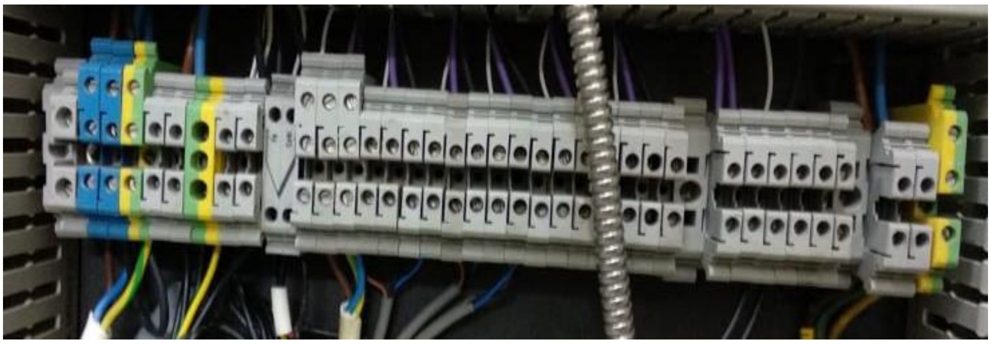
❖ دائرة القدرة

يمثل الشكل (1.4) دائرة القدرة خاصة بتشغيل مضخة الهيدروليك بالاضافة إلى السخانات المضافة لعمل الاختبار تحت تأثير الحرارة.



الشكل (1.4)

❖ توصيل الاسلاك على مجمع الاسلاك



الشكل (1.5)

عملية الترتيب في مجمع الاسلاك كما في الشكل (1.5) تبدأ من اليسار إلى اليمين حسب الترقيم التالي :

2+3 - مدخل الكهرباء (1 فاز)
5+6 - الحرارة
8+9 - التبريد الخاص بالحرارة
10+11 - حساس الحرارة
12 - المشترك لتوصيل الحساسات (+5V)
13+14 - حساس الضغط
32 – 19 - مدخل حساسات ذات الاشارة الواحدة (Digital Input)
33-40 - مخرج ذا الاشارة الواحدة (Digital Output)
41+42 - مخرج مضخة الهيدروليك

بسم الله الرحمن الرحيم

من: م. احمد الشريف مختبر دائرة الكهرباء

الى السيد: د. حسن عمر الحداد

الموضوع:. دليل المستخدم لجهاز اختبار الشد

تحية طيبة وبعد

اود ان اعلمكم بأن طلاب مشروع تحديث جهاز فحص الشد. قد اتموا عمل دليل المستخدم لجهاز شد الحديد وقمت بالتدقيق على تشغيل الجهاز بواسطة هذا الدليل.

مع التقدير

م. احمد الشريف

[signature]

٢٩/٤/٢٠١٩