DESIGN AND PRODUCTION OF A TEST DEVICE FOR THIN FILM TRANSISTOR BACKPLANE OF X-RAY IMAGERS

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MASTER THESIS
BIOMEDICAL ENGINEERING

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Prepared as
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I certify that in my opinion the thesis submitted by Ali Yaseen Ahmed AL RUBAYE titled "DESIGN AND PRODUCTION OF A TEST DEVICE FOR THIN FILM TRANSISTOR BACKPLANE OF X-RAY IMAGERS" is fully adequate in scope and in quality as a thesis for the degree of Master of Engineering.

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This thesis is accepted by the examining committee with a unanimous vote in the Department of Biomedical Engineering as a Master of Engineering thesis. 25.08.2023

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Ali Yaseen Ahmed AL RUBAYE

ABSTRACT

M. Sc. Thesis

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In this research, a device was designed, implemented, and operated to test TFT samples used in X-ray machines. The TFT sample is small in size and is accurate in its manufacture where the details of these samples cannot be seen with the naked eye, These samples may be damaged during manufacture and this damage will lead to the sample not working during its installation in the device, through this device we will be able to test the sample if it is working or not working. The sample is a matrix consisting of 256 pixels, which means that it consists of 16 columns and 16 rows (16 X 16), and for the purpose of testing this sample, these rows and columns must be equipped with voltages from external sources with a value of (0V, 15V, 20V), the device works to prepare these voltages for the sample through a dedicated adapter for this purpose that connects these voltages to the sample. In this device, three PIC16F873 microcontrollers were used, and a printed board (PCB) on which the electronic elements and components were installed. Microcontroller number one and

microcontroller number two work to count the matrix consisting of 256 pixels. The count starts from 1 to 256, Microcontroller number 1 will count the columns of the matrix from 1 to 16, this means that microcontroller No. 1 will operate relays 1 to 16 to supply the sample columns with a voltage of 20 volts in series. While Microcontroller number 2 will count the rows of the matrix from 1 to 16, this means that microcontroller number 2 will operate relays 1 to 16 to supply the sample rows with a voltage of 15 volts in series, and the default values for all relays are 0 volts. The device operates on 7.4-volt lithium-ion batteries, which are used to supply power to electronic components. They are rechargeable batteries with high capacity and long life. A mechanical part of a medical microscope was used for the purpose of carrying the sample and the adapter.

Key Word : TFT Thin-film transistor ; MC Microcontroller ; LED Light-Emitting Diode; LCD Liquid crystal display; PS   Power supply.

Science Code : 90519

ÖZET

Yüksek Lisans Tezi

X-İŞİNİ GÖRÜNTÜLEYİCİLERİNİN İNCE FİLM TRSNSİSTÖRLÜ ARKA PANELİ İÇİN BİR TEST CİHAZININ TASARIMI VE ÜRETİMİ

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Bu araştırmada, tıbbi görüntüleme cihazlarında kullanılan X-ray makinelerinde kullanılan TFT numunelerini test etmek amacıyla bir cihaz tasarlanmış, gerçekleştirilmiş ve çalıştırılmıştır. TFT numunesinin boyutu küçüktür ve bu numunelerin detaylarının çıplak gözle görülemeyeceği şekilde imalatı doğrudur. Bu numuneler imalat sırasında hasar görebilir ve bu hasar, numunenin kurulum sırasında çalışmamasına yol açacaktır. Bu cihaz aracılığıyla numunenin çalışıp çalışmadığını test edebileceğiz. Örnek 256 pikselden oluşan bir matristir, yani 16 sütun ve 16 sıradan (16 X 16) oluşur ve bu örneğin test edilmesi amacıyla bu satır ve sütunların harici kaynaklardan gelen voltajlarla donatılması gerekir. (0V, 15V, 20V) değerinde, cihaz bu voltajları numuneye bağlayan bu amaca özel bir adaptör aracılığıyla bu voltajları numuneye hazırlamak için çalışır. Bu cihazda üç adet PIC16F873 mikrodenetleyici ve üzerine elektronik eleman ve bileşenlerin monte edildiği bir baskılı devre kartı (PCB) kullanılmıştır. Bir numaralı mikro denetleyici ve iki

numaralı mikro denetleyici, 256 pikselden oluşan matrisi saymak için çalışır. Sayım 1'den 256'ya kadar başlar, 1 numaralı Mikrodenetleyici matrisin 1'den 16'ya kadar olan sütunlarını sayar, bu da 1 numaralı mikrokontrolörün örnek sütunlara seri olarak 20 volt voltaj sağlamak için 1'den 16'ya kadar olan röleleri çalıştıracağı anlamına gelir. 2 numaralı Mikrodenetleyici matrisin 1'den 16'ya kadar olan satırlarını sayarken, bu, 2 numaralı mikrodenetleyicinin örnek sıralara seri olarak 15 volt voltaj sağlamak için 1'den 16'ya kadar olan röleleri çalıştıracağı anlamına gelir ve tüm röleler için varsayılan değerler şu şekildedir: 0 volt. Cihaz, elektronik bileşenlere güç sağlamak için kullanılan 7,4 volt lityum iyon pillerle çalışır. Yüksek kapasiteli ve uzun ömürlü şarj edilebilir pillerdir. Numuneyi ve adaptörü taşımak amacıyla tıbbi mikroskobun mekanik bir parçası kullanıldı.

Anahtar Sözcükler : TFT ince film transistörü; MC Mikrodenetleyici; LED ışık yayan diyot; LCD sıvı kristal ekran; PS güç kaynağı.

Bilim Kodu : 90519

ACKNOWLEDGMENT

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ABBREVIATIONS

W   : Watt

V   : Volt

A   : Ampere

No   : Number

FL   : Flow code

S   : Second

MP   : Megapixel

ms   : Millisecond

mA   : Milliampere

PS   : Power supply

AM   : Active-matrix.

MC   : Microcontroller

DAQ : Data acquisition

TFT : Thin-film transistor

A-Si : Amorphous - silicon

LED : Light-emitting diode

PCB : Printed circuit board

LCD : Liquid crystal display

CT   : Computed tomography

NDT : Non-destructive testing

ADC : Analog to digital converter

DAC : Digital to analog converter

CHAPTER 1

X-RAY IMAGE SENSORS AND ACTIVE PIXEL ARRAYS

1.1. INTRODUCTION

X-ray image sensors and active pixel arrays play a crucial role in medical imaging and industrial applications. These technologies enable the conversion of X-ray radiation into digital images, allowing for accurate diagnosis and analysis. X-ray image sensors are electronic devices used to detect and capture X-ray radiation and convert it into digital signals. Active pixel arrays are a type of X-ray image sensor that consists of an array of individual pixels, each capable of independently detecting X-rays and producing an electrical signal proportional to the intensity of the radiation [1][2].

1.2. WORKING PRINCIPLE

X-ray image sensors utilize various methods to convert X-ray radiation into electrical signals. Active pixel arrays employ a direct conversion method. When X-ray photons pass through the sensor, they interact with a scintillator material, which converts the X-rays into visible light photons. These visible light photons are then detected by the pixels in the active pixel aray.

An X-ray image sensor based on thin-film transistor (TFT) technology is a type of device used to detect and capture X-ray images. It consists of a combination of scintillator material, a photodiode array, and an array of TFTs [3][4].

1.2.1. Scintillator

When X-rays strike a scintillator material, they generate light photons. The scintillator material converts X-rays into visible light, making it easier to detect and measure them [2].

1.2.2. Photodiode Array

The scintillator is coupled to a photodiode array, which consists of an array of small light-sensitive detectors called photodiodes. Each photodiode converts the incoming light photons into electrical signals [5][6].

1.2.3. Thin-Film Transistor (TFT) Array

The electrical signals from the photodiode array are then passed to an array of thin-film transistors (TFTs). TFTs are electronic devices made of thin semiconductor films that act as switches, controlling the flow of electrical current. Thin film transistor is a special type of MOSFET transistor, which is prepared by depositing a thin film of active semiconductor layer and other components onto a supporting substrate. Paul K. As shown in Figure 1.1. Weimer was the first to develop this transistor in the early 1960's at RCA Laboratories [7][8].
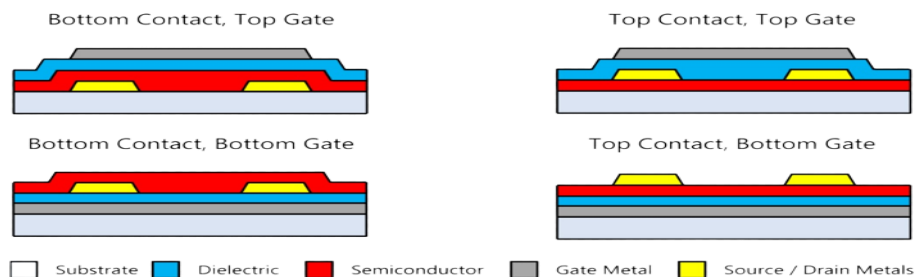
Figure 1.1. Types of field effect transistors.

1.2.4. Signal readout and processing

The TFT array reads out the electrical signals from the photodiode array and amplifies them. The signals are then processed and converted into digital data, representing the X-ray image [4].

1.2.5. Display or storage

The digital data can be displayed on a monitor or stored in a computer for further analysis, diagnosis, or archiving X-ray image sensors based on TFT technology offer several advantages, including high sensitivity, low noise, and the ability to capture X-ray images in real time. They are commonly used in medical imaging systems such as X-ray machines, computed tomography (CT) scanners, and digital radiography systems. It's worth noting that the specific design and construction of TFT-based X-ray image sensors can vary depending on the manufacturer and application. Different scintillator materials, photodiode array configurations, and TFT array layouts may be employed to optimize performance and meet specific imaging requirements [9].

1.3. COMPONENTS

An X-ray image sensor with an active pixel array typically consists of several keys

1.3.1. Scintillator Material

The scintillator material is usually made of a crystalline material or a phosphor that emits visible light when struck by X-ray radiation. It plays a crucial role in converting X-rays into detectable signals [2].

1.3.2. Photodiode

Each pixel in the active pixel array contains a photodiode, which is responsible for converting the visible light photons emitted by the scintillator into an electrical charge [5][6].

1.3.3. Charge Amplifier

The electrical charge generated by the photodiode is amplified by a charge amplifier circuit within each pixel. This amplification is necessary to enhance the signal strength and improve the overall image quality.

1.3.4. Analog-to-Digital Converter (ADC)

The amplified electrical charge is then converted into a digital signal using an ADC. This digital signal can be processed, stored, and displayed on a computer or imaging device [10].

1.4. ADVANTAGES

X-ray image sensors with active pixel arrays offer several advantages over traditional film-based X-ray imaging:

1.4.1. Digital Output

The direct conversion of X-rays into digital signals allows for immediate image acquisition, manipulation, and storage. Digital images can be easily shared, archived, and processed, enhancing workflow efficiency [11].

1.4.2. Improved Sensitivity and Dynamic Range

Active pixel arrays offer higher sensitivity and a wider dynamic range compared to film-based systems. This enables better visualization of subtle details and improves the overall image quality [12].

1.4.3. Dose Reduction

Active pixel arrays can be more efficient in capturing X-ray signals, reducing the required radiation dose for patients. This is important for minimizing the potential risks associated with prolonged or repeated exposure to X-rays. X-ray image sensors with active pixel arrays have revolutionized the field of medical imaging and industrial testing. Their ability to directly convert X-ray radiation into digital signals allows for real-time imaging, improved image quality, and dose reduction. With ongoing advancements in technology, these sensors continue to play a vital role in diagnostic medicine and various industrial applications [13].

1.5. APPLICATIONS

X-ray image sensors and active pixel arrays are widely used in various applications, including:

1.5.1. Medical Imaging

X-ray image sensors are essential for X-ray radiography, fluoroscopy, and computed tomography (CT) scans. They enable the visualization of bones, organs, and tissues, aiding in the diagnosis of fractures, diseases, and other medical conditions [14].

1.5.2. Non-Destructive Testing (NDT)

Active pixel arrays are used in industrial applications for NDT, where X-ray imaging is employed to inspect and evaluate the integrity of structures, welds, and

components without damaging them. This is crucial in industries such as aerospace, manufacturing, and automotive [15].
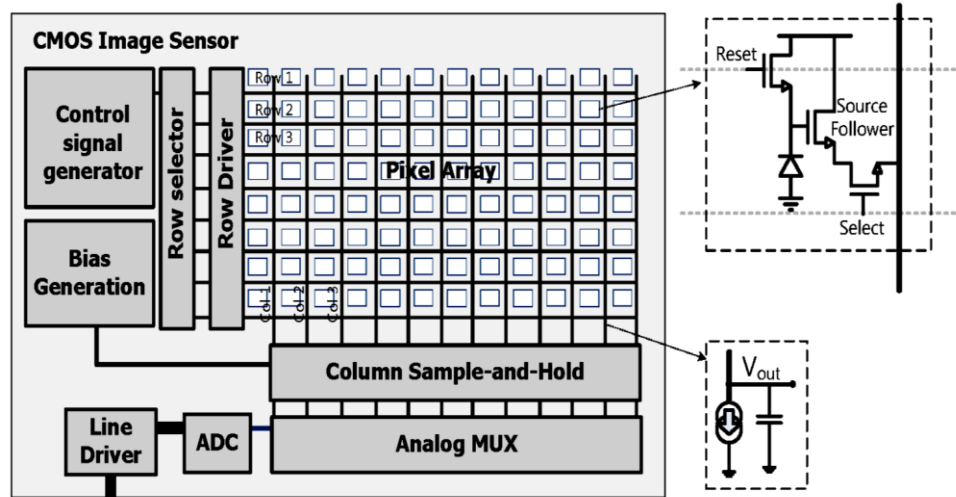
Figure 1.2. Basic CMOS image sensor structure. A pixel array is consist of 3T APS. A analog signal processors has column sample-and-hold circuit, analog-to-digital converter circuit (ADC), and bias generation [12].

1.6. DIFINITION OF PIXEL

A pixel is the smallest part of a digital picture or graphic that can be shown and reflected on a digital display. and A pixel is the basic logical unit in digital graphics. Pixels are combined to form a complete image and are the basic bit of color that can be changed on a computer screen or in an image. and it is not something you can touch.
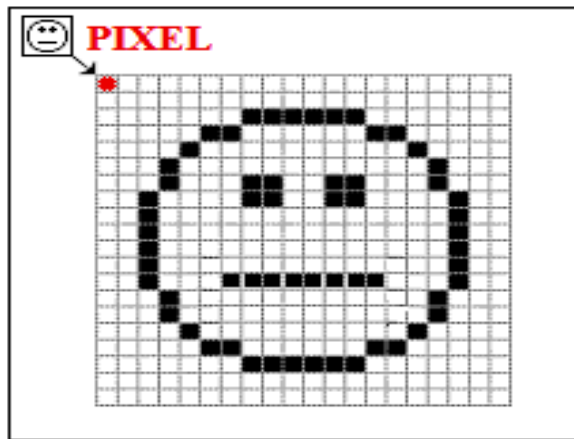
Figure 1.3. Pixel location

A megapixel (MP) is a million pixels. The term megapixel comes up most often in photography; however, screen resolutions can be measured in megapixels. For example, 4K is approximately 12 MP and 1080p is 2.1 MP.

1.7. THIN FILM TRANSISTOR (TFT) ARRAYS

Arrays of thin-film transistors (TFT) A display device is usually made up of a two-dimensional array of picture elements that can each be controlled separately (pixels). In an active-matrix thin-film-transistor liquid crystal display (AM TFT/LCD), there is one set of metal lines running horizontally and another set of metal lines running vertically on a different plane. At each pixel, the gate line is connected to the gate of a thin-film transistor (TFT), and the data line is connected to one of the TFT's sources/drains. terminals see Figure 1.4. The other source/drain terminal is connected to a transparent conductor, sometimes called a flag because of its shape, which is separate from the other pixels and acts as one electrode of a capacitor. The TFT array is the name for the two-dimensional array that is made on a glass substrate (back plate.
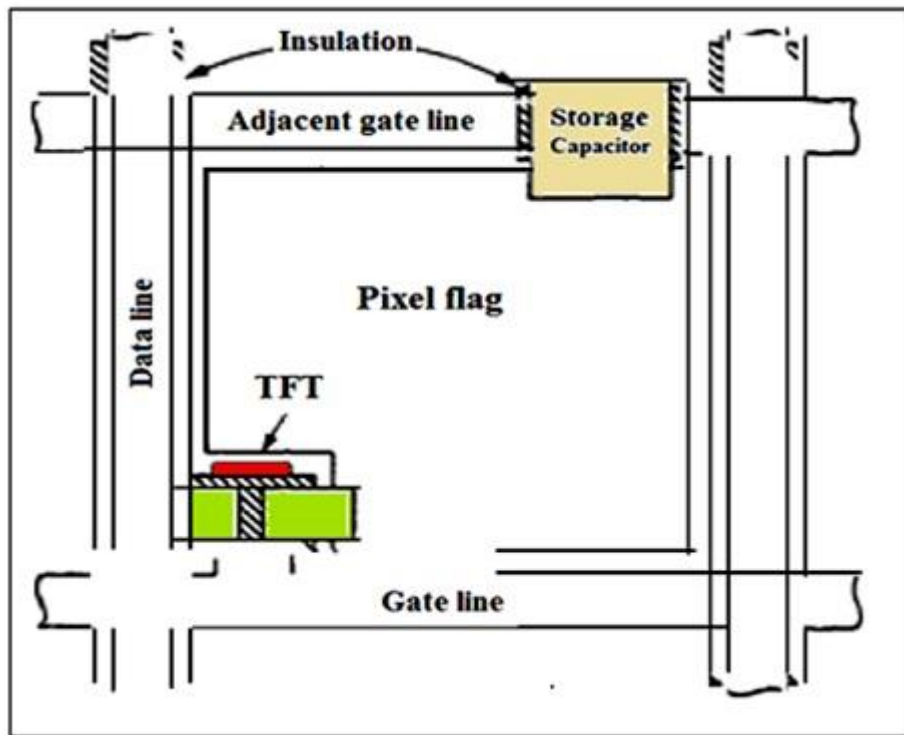
Figure 1.4. Image of a pixel layout. Here, the neighboring gate line is used as the opposite electrode of the storage capacitor. Some styles do this by using a separate line.

On a second piece of glass (the front plate), there is a layer of transparent conductor that acts as the other electrode for all of the pixel capacitors. This second piece of glass also has a repeating pattern of red, blue, and green filters for a color display. One filter is placed over each pixel, and the others are separated by a black matrix. A color pixel is made up of a red pixel, a blue pixel, and a green pixel. The two pieces of glass are lined up and glued together with spacers that are several pm thick. In between the two pieces of glass is a liquid crystal. The last step is to put linear polarizers on the outside of each piece of glass. A voltage is put on a chosen horizontal (or gate) line and a vertical (or data) line to control the pixels. In normal operation, a selected pixel must take a reading of the potential on its data line at a time set by the pulse on its gate line. This pulse briefly puts the TFT in the "ON" state. When ON, the potential of the liquid crystal pixel flag is the same as that of the data line. When the TFT goes back to the OFF state, there is still a potential on the flag, which is how the display system wants the pixel to transmit light. The pixel must now hold this potential for one frame until the next gate pulse refreshes it [5].

The voltage on the capacitor controls the rotation of linearly polarized light through the twisted nematic (TN) liquid crystal so that each pixel is now an electro-optical element that changes the amount of light from an area-uniform backlight. The way the TFT array is made on the first piece of glass is similar to how integrated circuits are made on silicon chips, but the sizes are much bigger. In fact, the TFT array is very similar to the array part of a DRAM chip. This is because a storage capacitor is often added to the TFT array to store more charge at each pixel and reduce some of the nonlinear effects of the liquid crystal capacitor. So, Figure 2 shows the TFT array, where each element is made up of storage capacitors that can be randomly accessed through a TFT access device [5][14].
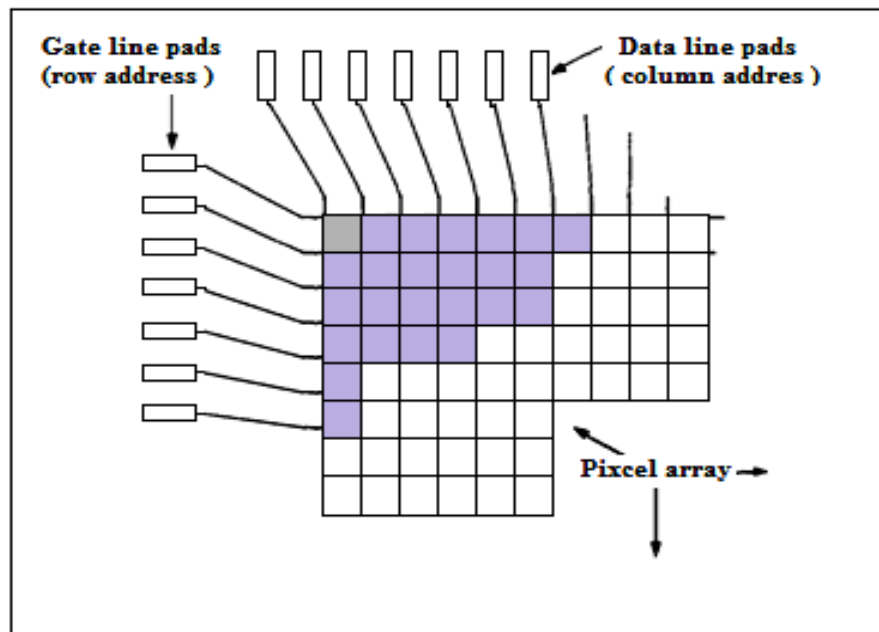
Figure 1.5. TFT Matrix representation [5].

CHAPTER 2

INTRODUCTION TO SEMICONDUCTOR DEVICE CHARACTERIZATION

One of the important parts used in X-ray imaging equipment and other medical imaging equipment are TFT chips these chips are made in a professional way by semiconductor materials.

2.1. BRIEF DEFINITION OF SEMICONDUCTORS

Semiconductor devices are electronic components that utilize the electrical properties of semiconducting materials to control the flow of electric current. These devices are integral to modern electronics and play a crucial role in a wide range of applications. Semiconductors have an intermediate level of electrical conductivity between conductors (such as metals) and insulators (such as rubber or wood). Their conductivity can be modified by adding impurities or applying external factors like temperature or light, to the semiconductor crystal lattice. Dopants can either donate extra electrons (n-type doping) or create electron deficiencies called "holes" (p-type doping). Transistors are fundamental semiconductor devices that amplify or switch electronic signals. They consist of multiple semiconductor layers and are typically used as voltage or current amplifiers, switches, or digital logic elements. and designing, fabricating, and utilizing electronic devices across various industries, including telecommunications, computing, power electronics, and consumer electronics [16].

2.2. FUNCTIONAL TESTING OF TFT/LCD ARRAYS

Mr. Jenkins, an engineer in thin-film transistor materials, managed with a team to design and manufacture a device for testing TFT samples, A complete test system provides an interface with an operator, performs test functions, analyzes data, and

logs the results. Figure 2.1. gives an overview of our system. System control resides with an IBM PS/2 that is connected to the tester through a digital I/O board on the Micro Channel bus [5].
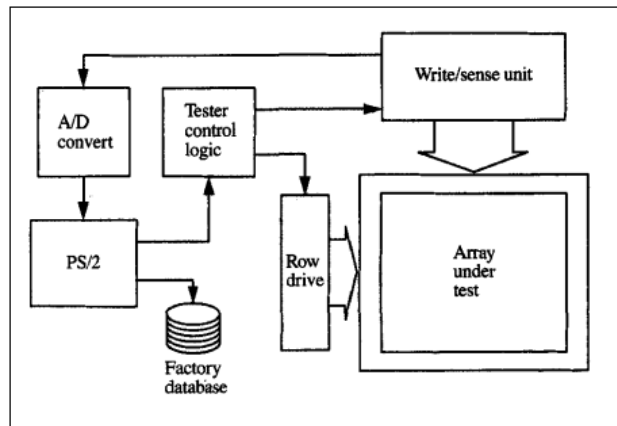
Figure 2.1. Dynamic Array Tester system [5].

The hardware design of the Dynamic Array Tester provides control of most test conditions to the software. All test parameters, including row and column addresses, pulse timings, and voltage levels, are available for manipulation by the test program. As required by the various tests, conditions can be set for writing a pixel with a wide range of values. Figure 2.2. shows an example of a complete test system. While looping, the computer repeats the cycle of sending parameters to the tester, triggering a test, reading the analog-to-digital converters, and storing the data in a memory array. After exiting the loop, the software analyzes the data by looking for specific response signatures as described above. Defect locations are identified [5].
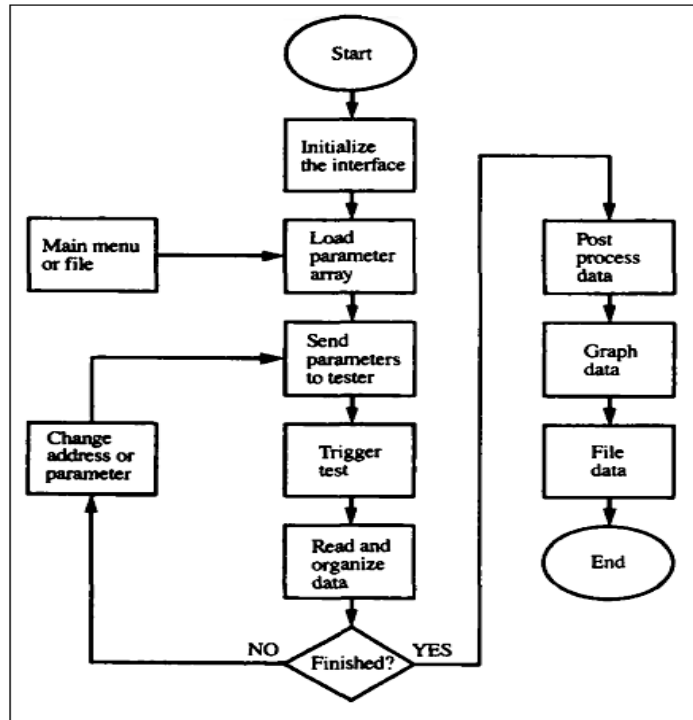
Figure 2.2. Software flow diagram [5].

2.3. DEVICES AND COMPONENTS USED FOR THE TFT SAMPLE TESTING DEVICE

In our research, a device was designed and implemented to test the TFT sample used in X-ray radiography devices, that TFT samples are precision-made samples and are manufactured under special conditions, sometimes some minor errors occur during manufacturing, which leads to damage to that sample and that means it does not work well, all manufacturers of new spare parts must work to conduct a test on a sample to PCB printing has been designed for this purpose, these processors work which are of the PIC microcontroller type According to a program written to work as a matrix that counts pixels for 16 bits, this means that the sample contains 16 rows and 16 columns (16X16), and this also means that the sample contains 256 pixels, and to test this sample, the program will count from (1-256), and this is done by shining a constant constant voltage on the columns and rows of the sample sequentially, and here a DC continuous power 20 volts, by means of an adapter that connects the sample to the device designed for this purpose, and figure (2.3) shows the devices used and the method of connecting them to the circuit.
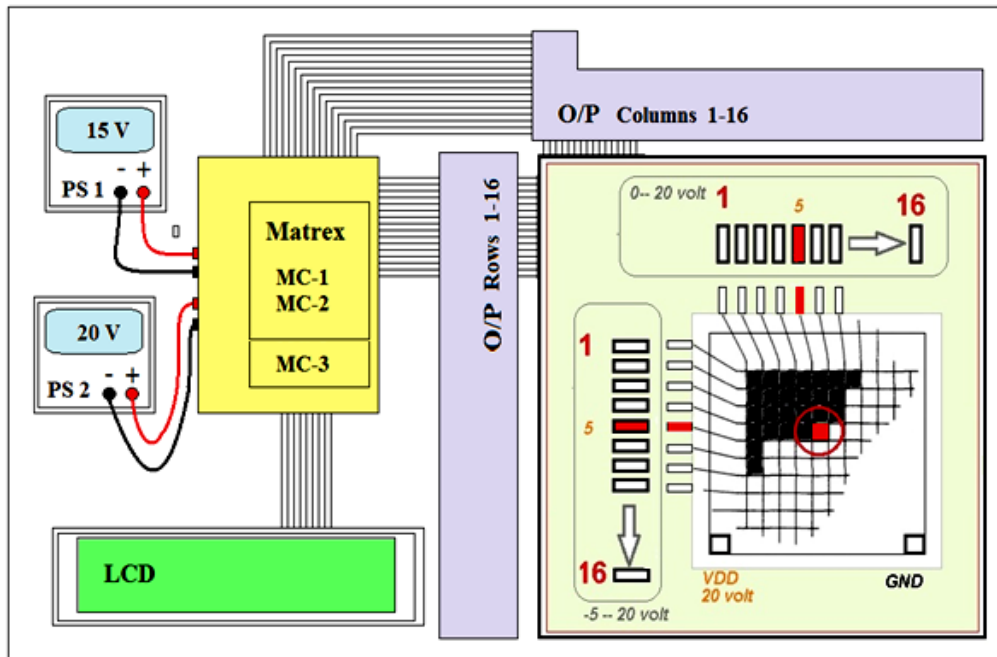
Figure 2.3. Test device for thin film transistor backplane of X-ray images.

2.4. BLOCK DIAGRAM OF THE TEST DEVICE OF THIN FILM TRANSISTOR

The figure below represents the block diagram of the TFT sample tester used with X-ray machines, we note the block in red represents the electrical power supply of the device(PS), this unit supplies the device and the sample with different voltages, for the yellow block it represents the sample under test, the two blocks in blue represent the first microcontroller for the columns of the matrix, the second represents the microcontroller for the rows of the matrix, the block in green represents the LCD liquid crystal display and figure (2.4) shows this.
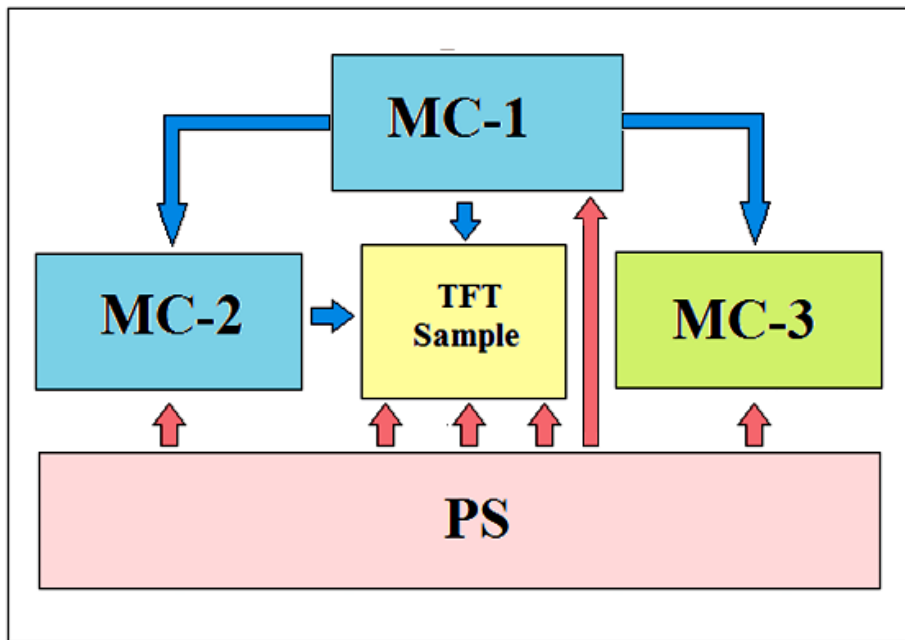
Figure 2.4. Block diagram of the device.

CHAPTER 3

INSTRUMENTATION OF A PIXEL ARRAY TEST DEVICE

The rapid development that is taking place in technology in our current world is to serve humanity, that is, to make human life better. The tremendous development in the field of artificial intelligence, robotics, and industrial automation, all of these things have made man shorten the time in completing his work. All modern industries at present depend on working independently without interference Human, for example, the manufacture of cars, the manufacture of heavy machinery, aircraft, and most of the delicate electronic devices that we use in our daily lives are manufactured and assembled by robots that work with the automation system and artificial intelligence. What do we mean by automation, The industrial automation system has caused massive human unemployment, and the reason for that is that these machines can perform the job of more than one human worker at one time. Among the advantages of these machines and these modern systems are accuracy and speed without accidents, which in turn will lead to an increase in production in a short time and without problems. Or errors in production. As for the human factor, it is possible that a person, while working for long hours, will be exposed to stress and fatigue. Consequently, this may lead to some accidents or errors during work, which in turn will lead to slow work and lack of production, and this is the most important reason that led to the replacement of the human element with machines and robots that operate with automation and artificial intelligence. In this research, we will talk about a device for testing TFT samples of devices X-rays, which are small samples whose dimensions do not exceed 2 cm. These samples are made with high accuracy and under special conditions and laboratories. These samples are so accurate that the details of their manufacture cannot be seen with the naked eye. The sample that will be tested is a thin glass slide, which is a matrix consisting of 256 Transistor, which means that it is a matrix consisting of 16 rows and 16 columns, which means

(16x16). The device here will test this sample by itself without any human intervention.3 microcontrollers were used in this device. The first is used as a counter for the matrix columns, the second is used as a counter for the rows of the matrix, and the third will be for the liquid crystal display through which we will see the values of the counters in the form of numbers, and we will discuss in our research this mechanism Work and function of each microcontroller.

Manual measurement of all 256 in pixels one-by-one with a probe station consumes several days depending on the experience of the operator. However, automatic measurement will last only a few minutes with this device.

3.1. PARTS OF THE DEVICE

Every electronic device that works with an artificial intelligence system and an automation system or robots must contain programmable processors such as a microcontroller. And converting it into machine language and transferring it to the microcontroller through a special programmer for this purpose, and for this microcontroller to work in the circuit, there must be some electronic elements that help in the work, which are as follows .

- Printed Circuit board PCB
- Microcontroller
- Integrated circuit socket
- Crystal
- Resistors
- Photo coupler
- Voltage regulator
- Light Emitting Diodes
- Buzzer
- Relays (5V)
- 2x16 LCD Display Segment
- Switch
- Lithium-ion batteries

- Battery charger

- Pin-header connectors are male & female

- Banana plug female

- IDE Ribbon 40 Pin

- Transparent acrylic for the outer cover

- Mechanical part

- Adapter pins

- Mobile holder

3.2. PRINTED CIRCUIT BOARD

PCB or Printed Circuit Board is the traditional name for the bare board which you supply us with the layout data and which you use to mount your components once we have delivered it to you. A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks, or signal traces etched from copper sheets laminated onto a non-conductive substrate. and The figure 3 1 below shows the PCB.
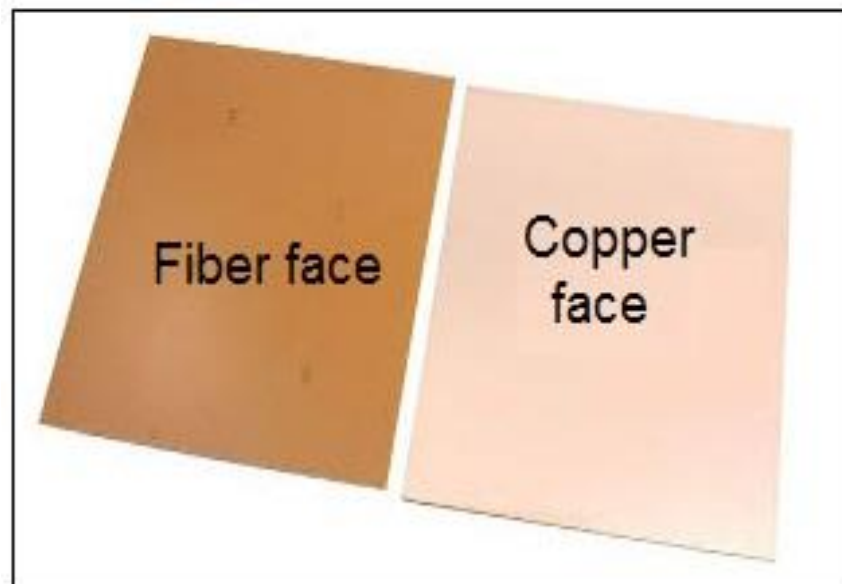
Figure 3. 1. Printed cirrcuit board PCB

This board collects all the electronic elements of the device, and to manufacture this board, the circuit must be designed, The available Proteus simulation program has been used, and after making sure that the electronic circuit is valid, we are working on designing an image of the PCB using the PCB ARES program, and this program is part of the Proteus program. After designing the board connections, it is printed on paper by a laser printer. After printing, the surface must be cleaned The plate coated with copper is cleaned well, then the printed paper is placed on the surface of the copper, and high heat is applied to it using a clothes iron for a time about five to 10 minutes. After this method, the printing will move from the paper to the copper or the surface of the copper, and then the PCB copper plate is placed with a FICl3 solution for a period of 20 to 30 minutes to dissolve the unprinted copper. After this process, the board is cleaned with water, and then drilled with a drill according to the points specified, and the image below shows how this works.
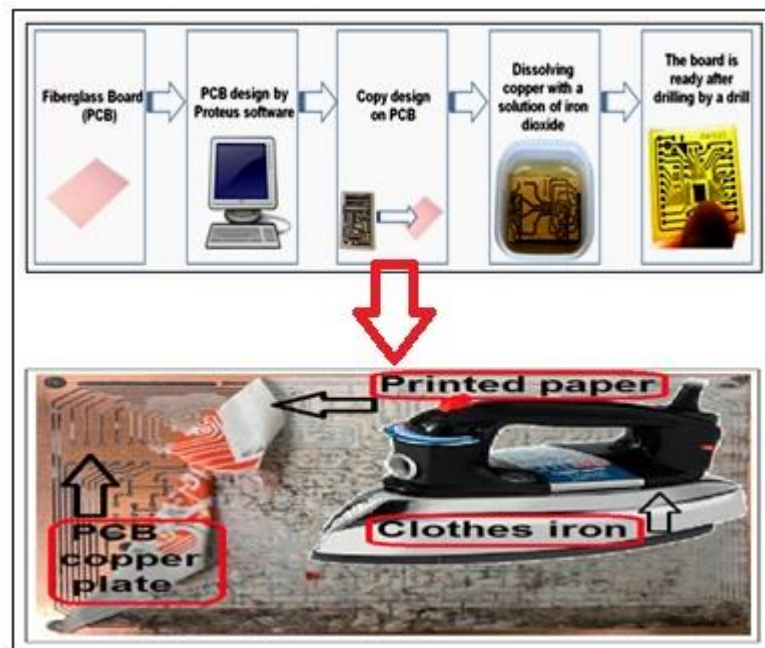
Figure 3.2. Method of making a printed circuit board .

3.2.1. Pictures of the PCB boards that were used in the device
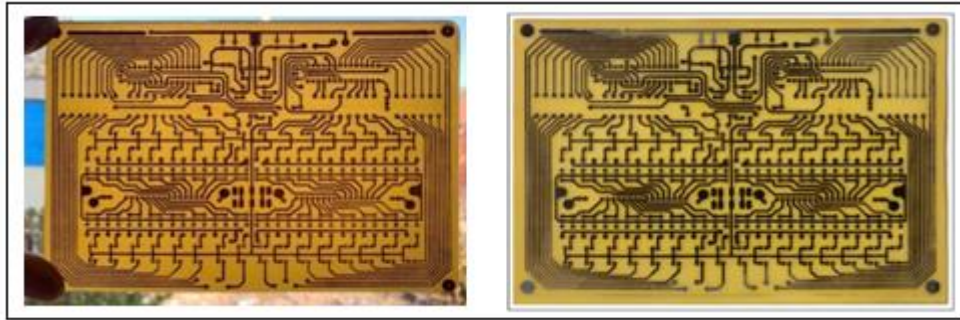
Figure 3.3. PCB Mother board .
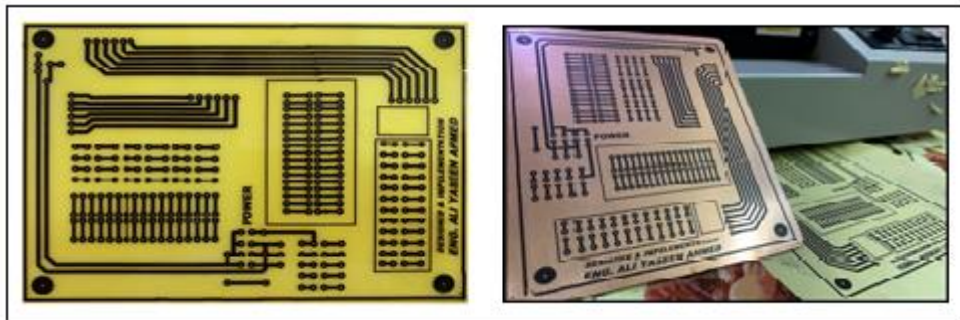
Figure 3.4. PCB Power supply.
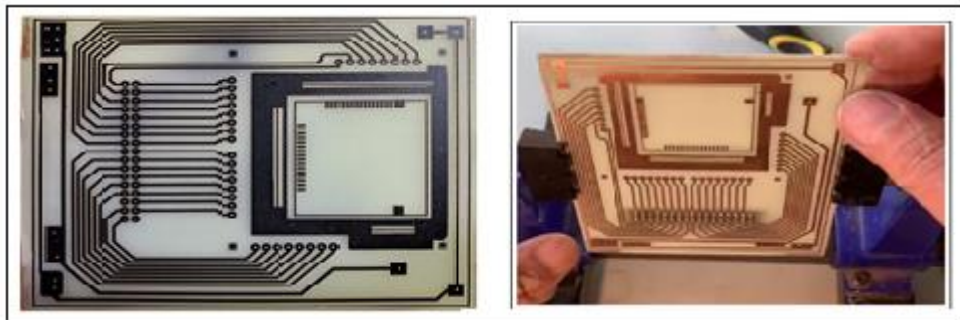
Figure 3.5. PCB Adapter .
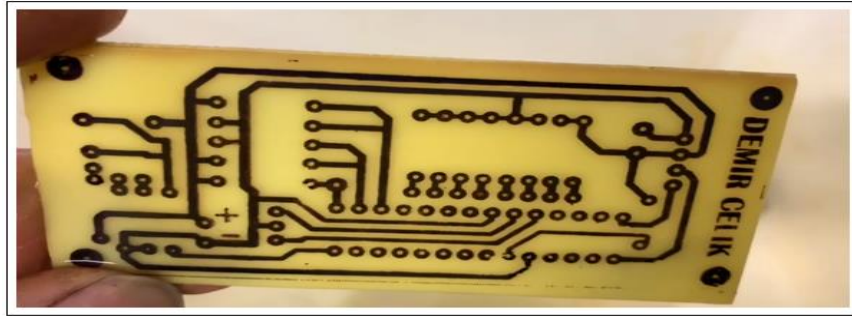
Figure 3.6. PCB – liquid crystal display.

3.3. MICROCONTROLLER

This type of PIC16F873A is one of the most widespread and (popular) types of PIC microcontrollers. It is an integrated circuit and consists of 28 DIP terminals in two rows, each row contains 14 pins. This type of microcontroller contains four ports, which are the rescuer A, and it consists of (RA0 To RA5), which is an analog port and is also considered (A/D) and port B, and consists of (RB0 to RB7), which is an analog port, and port C, and consists of (RC0 to RC7), which is also an analog port, and these ports can be specified as input or output ports as desired and this The PIC16F873A microcontroller contains a powerful and good memory that can perform a lot of tasks, and this means that it can be used in different projects [17].
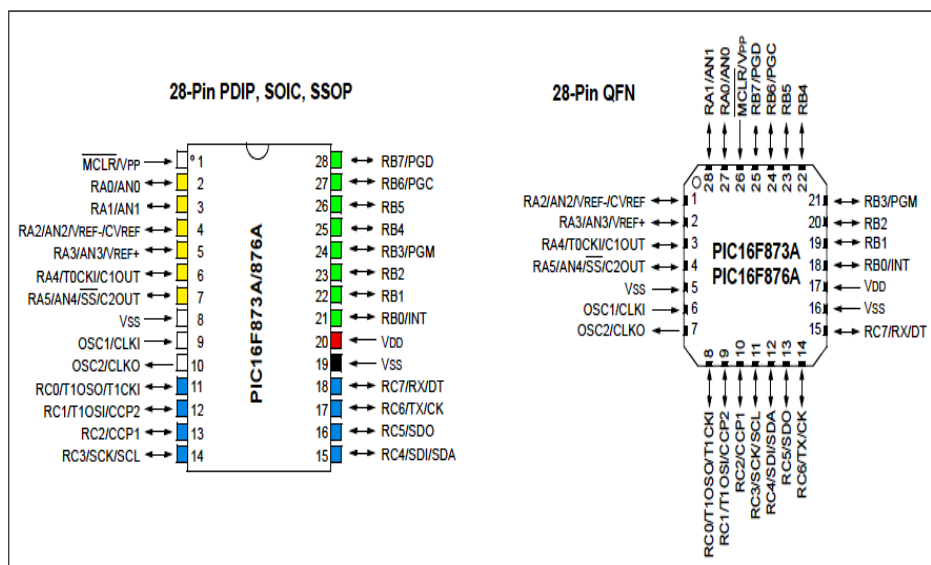
Figure 3.7. Microcontroller pin diagrams [17].

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3.3.1. Data Memory Organization

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 (Status) and RP0 (Status) are the bank select bits. Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access [17].
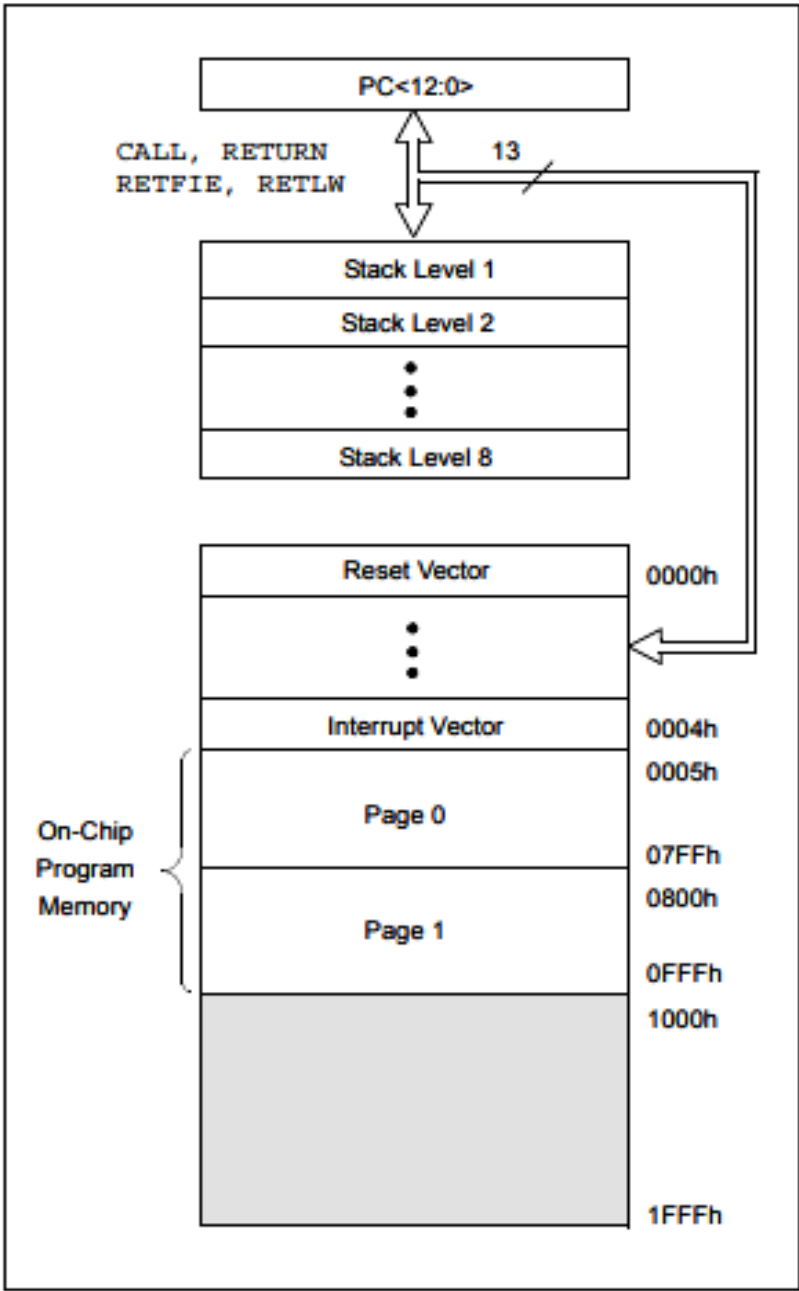
Figure 3.8. PIC16F873A/874A Program memory map and stack [7].

3.3.2. Block diagram PIC 16F873A
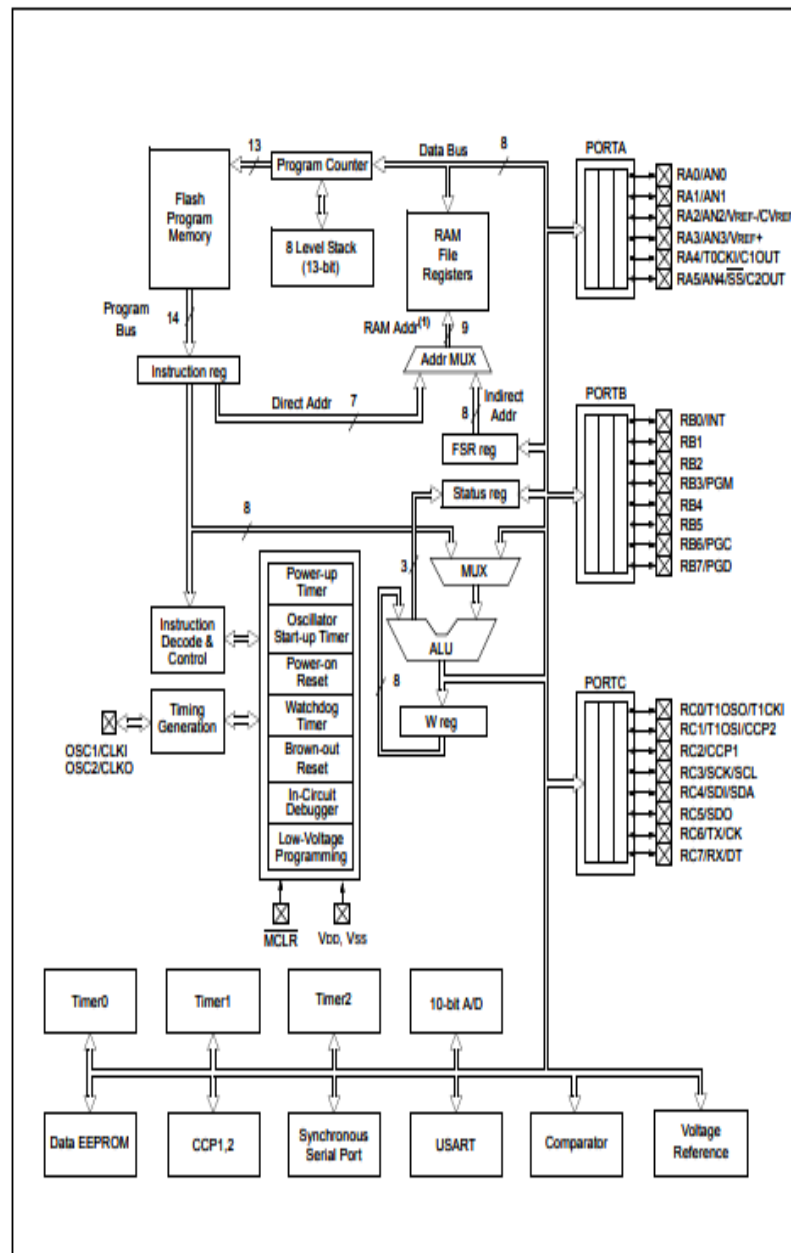
Figure 3.9. Block diagram pic16f873A [17].

3.4. BASE OF THE MICROCONTROLLER

It is the socket that connects the integrated circuit to the PCB board. This means that it is a link between the integrated circuit and the PCB [18]. One of the advantages of using a socket is that it prevents damage to the integrated circuits during direct

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soldering to the PCB. In this case, the socket will be soldered to the board first, and then the integrated circuit will be installed in the socket easily without soldering, which means that the integrated circuits can be easily inserted and removed in case of damage without damaging the PCB, which may be damaged during repeated soldering. Figure 3.10. The PIC 16F873A microcontroller socket is shown [19].
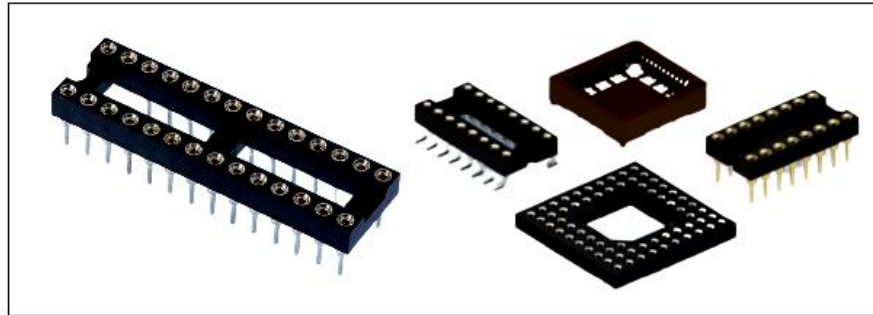
Figure 3.10. Base of the microcontroller.

3.5. CRYSTAL

Quartz is used as an oscillator with the microcontroller and works to provide the system frequency for the work of these microprocessors and this frequency is the beating heart of the work of these processors, as in Figure 3.11. The reason for using the crystal shown below is because it is small in size, low cost, and with high stability during work [20][21].
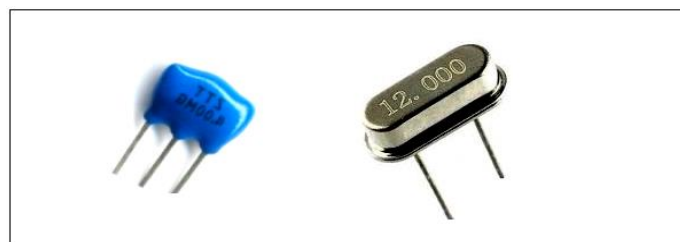
Figure 3.11. Crystal .

3.6. RESISTORS

Resistance was used in this research to reduce some voltages on the following parts, light-emitting diodes, and photo couplers, to preserve them from damage, and also

resistors were used to bias some micro control ports in the case of using them as output ports as shown in figure 3.12. [22].
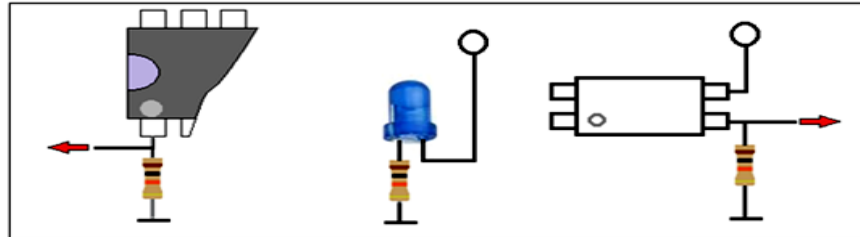
Figure 3.12. Resistors.

3.7. PHOTO COUPLER

This electronic element consists of four pins and sometimes eight pins and sometimes 16 pins, depending on the number of ports, in this research we used the first type, which is the type that contains four pins, the pin No. 1 and pin No. 2 are connected to the light-emitting diode and pin No. 3 and pin No. 4 are connected to the optical transistor, which will work to connect in the event of the passage of an electric current to the diode This means that this electronic element does not rely on external light in its work, but deals with the electrical signals entering it through the light-emitting diode linked to pin No. 1 and pin No. 2 as figure 3.13. [23][24].
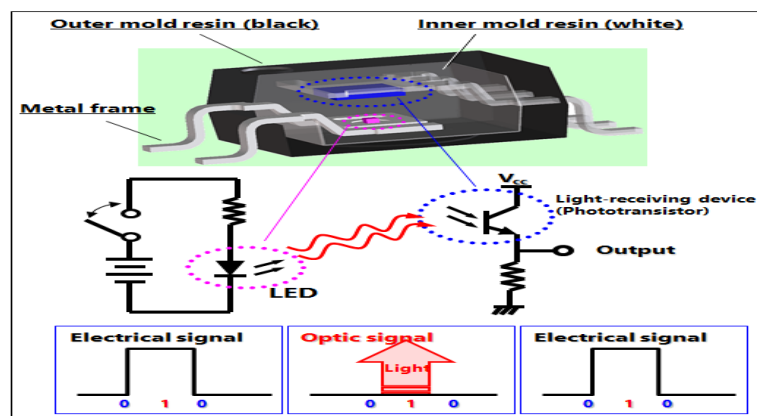
Figure 3.13. Photo coupler diagram.

Using PC817 optocoupler is very easy, there are four pins shown in the above pinout details. The pin 1 is anode or positive pin of the IR LED should be connected from the output signal of your circuit and pin2 should be connected to the ground. The other part of the circuit which you want to isolate or controlled should be connected with the pin3 (Emitter of the photo transistor) and pin4 (Collector of the photo transistor). The pin3 and pin4 works same as any other normal transistor for example a BJT transistor's emitter and collector.

3.8. VOLTAGE REGULATOR LM7805

It is an integrated circuit for a constant output voltage stabilizer of 5 volts and consists of three parties, terminal No. 1 to enter voltages (7-35 V), terminal No. 2 connects to the negative battery or transformer, and terminal No. 3 will be the output of the circuit and its value is (5 V), as shown in Figure 3.14. and this regulator is considered one of the fixed linear voltage regulators [25].
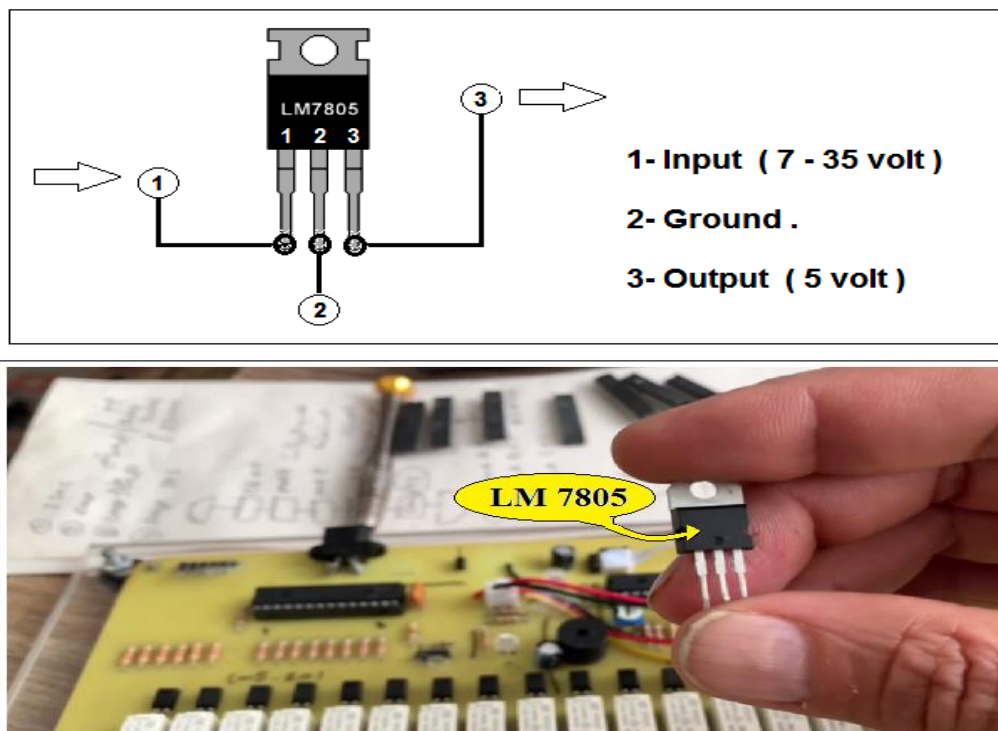
Figure 3.14. Voltage regulator and pin information.

3.9. LIGHT EMITTING DIODE (LED)

It is an electronic element of semiconductors emitting light during processing with continuous voltages and this electronic element is characterized by its small size, low energy consumption, and long life, this electronic element consists of two poles cathode and anode, and the shape below 3.15. shows this element and the way it is connected was used in our research this to indicate the work of the stages of the device is considered as a floodlight for the presence of voltages [26].
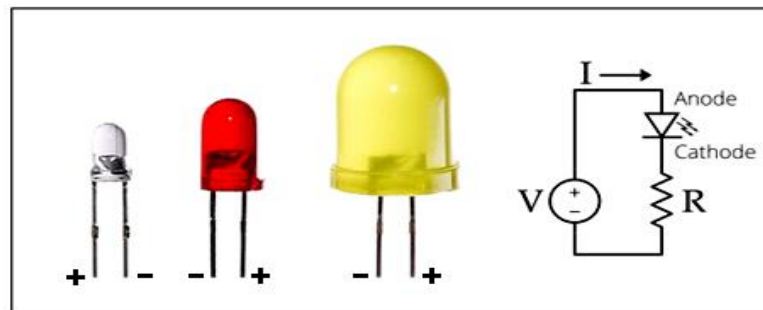
Figure 3.15. Light emitting diode information

3.10. ALARM CIRCUIT/BUZZER

This electronic element works to convert electrical signals into audible audio signals and works on a continuous voltage of (5 volts) and is used in various applications and devices such as computers, printers, alarms, and many projects, this element was used in our research to give intermittent whistling in the case of the beginning and end of the program [27]. As shown in Figure 3.16.

Figure 3.16. Circuit/Buzzer.

3.11. RELAYS (5V)

32 small-size relays operating on voltages of 5 volts were used, 16 relays were added to the MC1 exits No. 1 after the columns of the matrix, and 16 were added to the MC2 exits No. 2 after the rows of the matrix, and the relay function is here in order to equip the sample with the required voltages for the purpose of conducting the test and knowing its validity [28]. As shown in Figure 3.17.
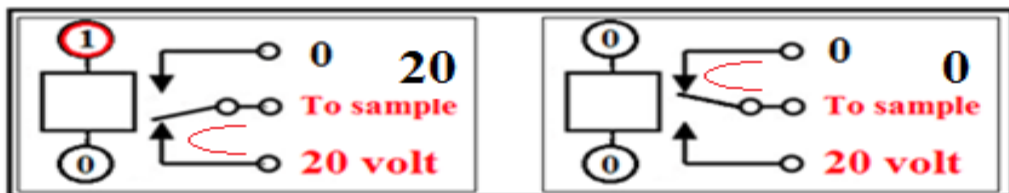
Figure 3.17. Relay pin out.
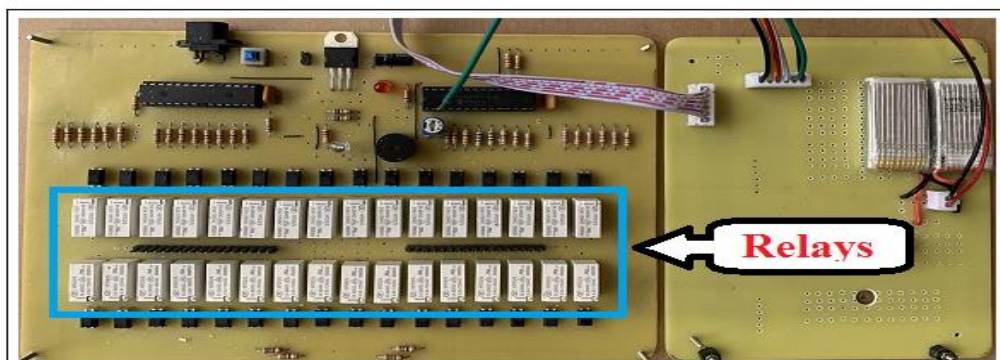
Figure 3.18. Relays location.

3.12. 16*2 LCD DISPLAY SEGMENT

Computers, calculators, televisions, mobile phones, and digital clocks use liquid crystal displays have been used The use of these screens has become widespread. in our this research, this liquid crystal display (2x16) was used to show text messages during the work of the device or show numbers resulting from the work of counters, and the number (2x16) means that it contains 16 characters per row ‹and the screen contains only two rows ‹and each letter consists of a matrix (5 × 7) to form the letter to be displayed on the screen [29]. As shown in Figure 3.19.
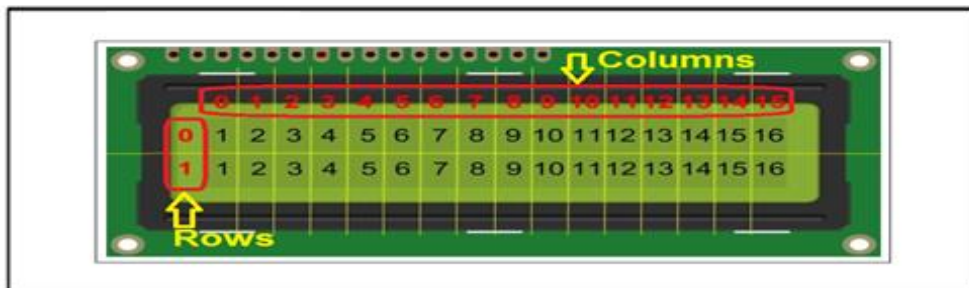
Figure 3.19. Liquid crystal display.

3.13. SWITCH

Each electrical or electronic device must contain a key to force the operation and extinguishing and in this device, three keys were used, the first key in red for turning on and off the device, the second key in blue for turning on and off the light-emitting diode in the platform carrying the sample, and the third key in green for zeroing the MC1, MC2, MC3 processors, which means restarting the processors without turning off the device as shown in Figure 3.20. [30].
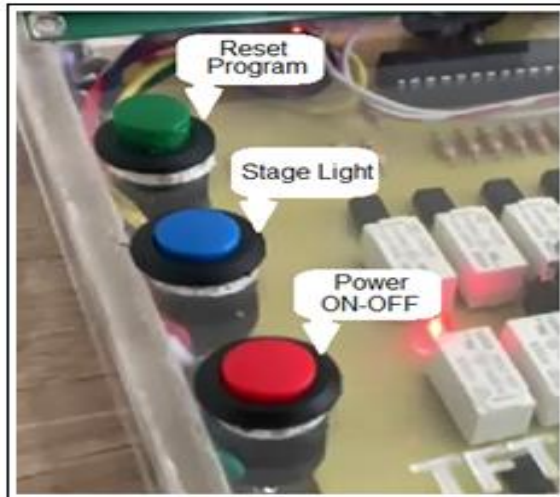
Figure 3.20. Front panel switches.

3.14. LITHIUM-ION BATTERIES

All the effective electronic elements in electronic circuits need electrical energy to work, two lithium-ion batteries with a capacity of (3.7V) have been added, and they have been connected respectively in order to obtain a voltage of (7.4V), this voltage is reduced to 5 volts by the voltage regulator LM7805, because the electronic circuit of the device works on a continuous voltage of (5V). As seen in figure 3.21.
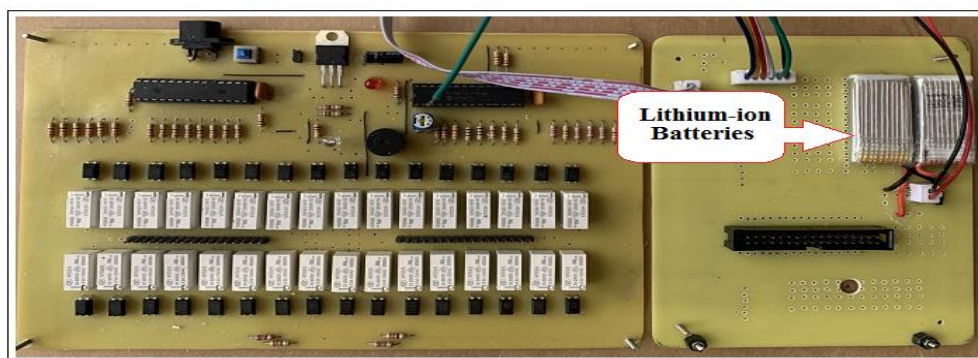
Figure 3.21. Lithium-ion batteries.

3.15. BATTERY CHARGER

The function of the electrical adapter is to recharge the lithium-ion batteries used in the device, in the event that the device is turned on for a period of more than 2 hours, there will be a drop in the batteries' power, and therefore we will need to recharge these batteries by this adapter as seen in figure 3.22.

Figure 3.22. Battery charger.

3.16. PIN-HEADER CONNECTORS ARE MALE AND FEMALE

Pin head connector is one of the types of connectors and its widely used in electrical and electronic circuit boards, PCB boards, and computers, The function of these connectors is to transfer signals and digital data between two stages within the device, and in this test device these connectors were used to connect between the test board and the sample adapter as shown in figure 3.23.

Figure 3.23. Pin-header connectors are male & female.

3.17. BANANA PLUG FEMALE

These ports have been added banana plug female so that we can equip the device with external power sources, the red and yellow color is equipped with a 20-volt continuous power source, and the green and blue color is equipped with a 15-volt continuous power source, and for the black color, it will connect to the negative pole for all power sources as shown in figure 3.24.
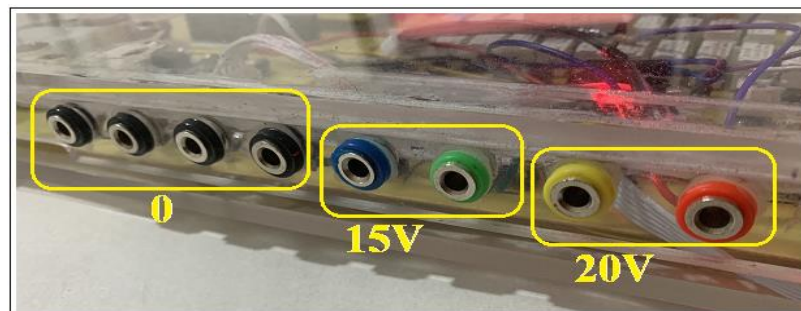
Figure 3.24. Banana plug female.

3.18. IDE RIBBON 40 PIN

It is the tape that connects the motherboard of the device to the adapter, which is directly connected to the sample that we want to test, this tape consists of 40 pins, which works to connect the voltages that are processed by external sources, represented by 20 volts, 15 volts, and zero volts, as shown in figure 3.25.

Figure 3.25. IDE ribbon 40 Pin.

3.19. TRANSPARENT ACRYLIC FOR THE OUTER COVER

Acrylic is one of the most widely used synthetic materials in the world. Even if you haven't heard of this type of plastic before, chances are that you've at least come into contact with or used it at some point in your life. Acrylic is extremely versatile and strong, making it perfectly suitable for a wide range of applications across numerous industries. The outer cover of the device is designed from this material after taking the measurements of the PCB board of the device, cutting it by laser, and the parts were assembled and glued with chloroform as shown in figure 3.26.
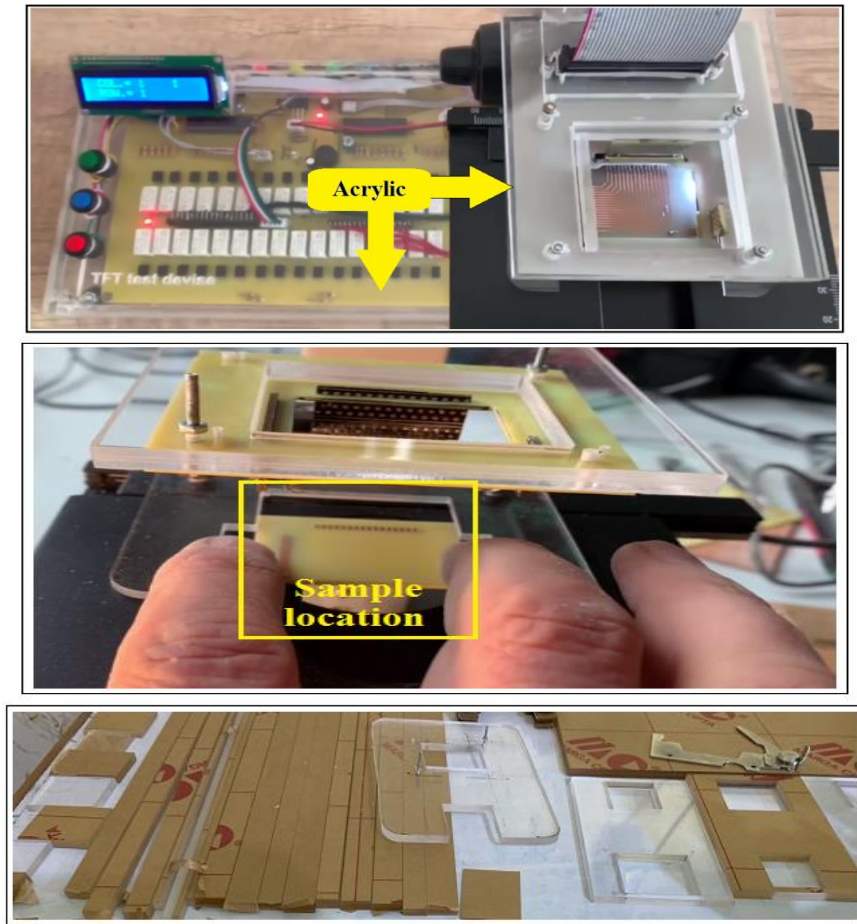
Figure 3.26. Transparent acrylic for the outer cover and adapter.

3.20. MECHANICAL PART

The mechanical part used in this device is a mechanical part of the microscope platform, some parts of the microscope were cut to obtain the platform and its supporting column, where the neck carrying the rotating disk carrying the objective lenses was cut as in the figure 3.25. the sample to be tested is installed on the platform as in the figure 3.24. and the adapter will be installed on the supporting column of the platform, which works to connect the voltages from the main board of the device to the sample as in the figure 3.27. The platform can be moved in all directions and easily forward and backward, to the right and to the left, and up and down by knobs designed for that and the purpose of this movement is so that we can make a match between the pins of the adapter and the sample.
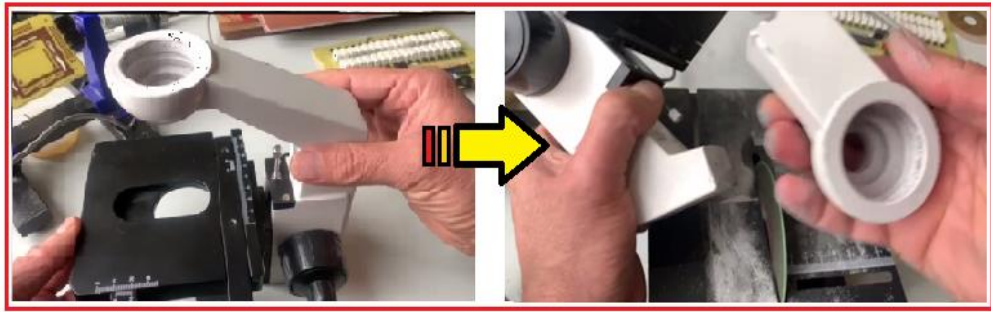
Figure 3.27. Cutting the neck of the microscope from the supporting column of the platform (arm).
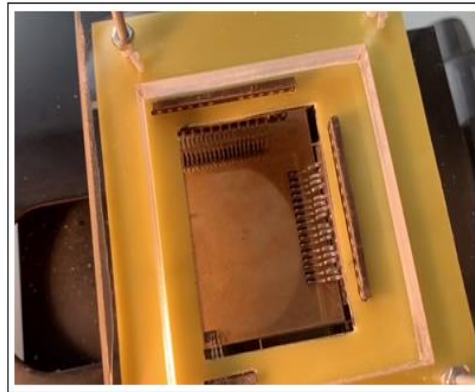
Figure 3. 28. Adapter

Figure 3.29. Platform.

3.21. ADAPTER PINS

The adapter is the basic link between the main card and the sample It works to transfer voltages from the card to the sample through the data transfer cable for the

purpose of testing the sample, and the manufacture of the adapter was done using the slot pins of the computer ram, and welded on the PCB board that was designed for this purpose and the figure 3.30. shows the pins used in this adapter.
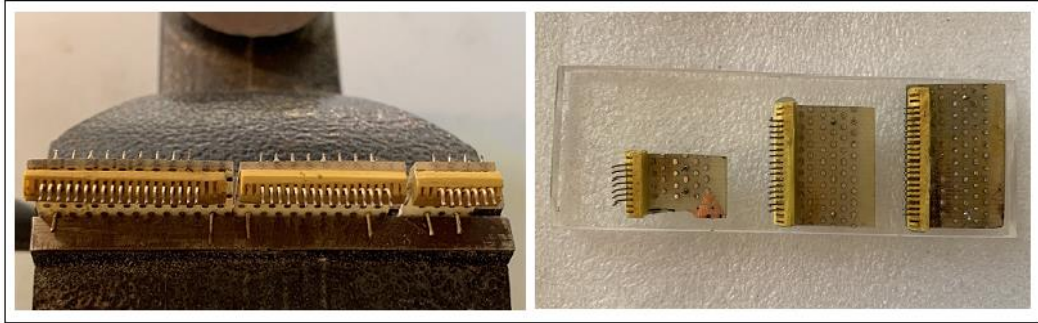
Figure 3.30. Adapter pin.

3.22. MOBILE HOLDER

Mobile holder, this holder was used to carry the mobile as in Figure 3.31. the aim of it is to enlarge the image of the pins in the adapter during the process of matching between the pins and the sample, where the sample is installed on the platform, and as we mentioned earlier that the platform can be moved easily and in all directions by knobs installed in the mechanical part, where there is a knob that moves the platform forward and backward, and there is also a knob that moves the platform to the right and the left, and these knobs are installed next to The platform and there is another knob installed on the arm carrying the platform and the function of this knob is to move the platform up and down as in Figure 3.31. for the adapter will be fixed on the arm, meaning it will be immobile and the platform will be mobile.

Figure 3. 31. Mobile holder
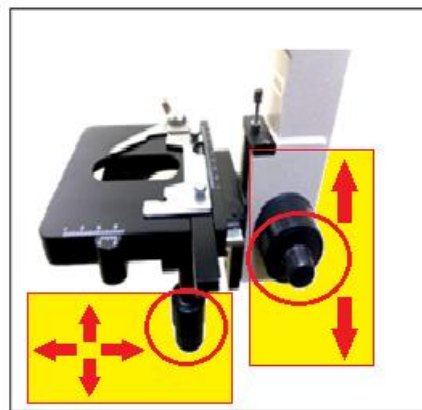
Figure 3.32. Knobs.

3.23. HOW DOES AN ELECTRONIC CIRCUIT WORK

This electronic circuit was implemented for the purpose of checking and testing the TFT samples used by X-ray machines, which are small in size and accurate manufacturing, all the parts that are manufactured in factories if they are electronic, electrical or mechanical should be subjected to testing, figure no 3.33. shows the circuit diagram for checking and testing the TFT samples used by X-ray machines, this circuit consists of three processors PIC16F873A, the first and second microcontroller operates a matrix consisting of 16 columns and 16 rows, the the first microcontroller contains a program that works as a counter for counting columns from (1-16), while the second microcontroller works as a counter for counting Rows from (1-16), and the work of the second microcontroller depends on the work of the

first microcontroller, and this means that there is synchronization between MC1 and MC2, at the beginning of the device's operation, the microcontroller No. 2 will start outputting the logic value (1) on the first output port and the rest of the (15V) outputs will maintain the digital value (0), this means that the first row will be equipped only with a voltage of (15V) via the relay connected to Port No. 1 for the microcontroller number (2) of the rows. Here the microcontroller number (1) will start the counting process from (1-16) will work to output the value of logic (1) on the first output port specified by the program, and this will lead to the operation of relay number (1) connected with the first output port with a time value of (1second), which will equip the first column of the sample with a voltage value of (20 V), and here we will notice the work of Pixel number (1) only from column number (1), the reason is that all the outputs of the microcontroller number (2 they output logic (0) only the first row outputs logic (1) means that the relay number (1) works only, which will equip the first row with a voltage of (15V). The counting process continues for the microcontroller no. (1) of the columns, after 1 second the relay No. (1) of the columns will stop and the second relay will work, and here the Pixel No. (2) will work, and the counting continues to the relay No. (16) at the end of the counting after (1second) the microcontroller no. (1) of the columns will send the first pulse to the microcontroller no. (2) of the rows for MC2 to change the count from (1 to 2), this means that the relay No. (1) of the first row and the relay No. (2) of the second row stop to start completing the count from (17-32), and at the end of the count (32) the relay No. (2) of the second row will stop and the relay No. (3) to complete the count from (33-48), and the counting continues Columns until the count reaches row (16), which is the last row in the matrix, in which the pixel count of the sample will end to 256, after which the program will stop . As for the microcontroller number (3), its function is to show text messages at the beginning and end of the program, and to show the counting values for both MC 1 and MC 2 on the liquid crystal display. Figure no. 3.34. show the electronic circuits of the three processors .
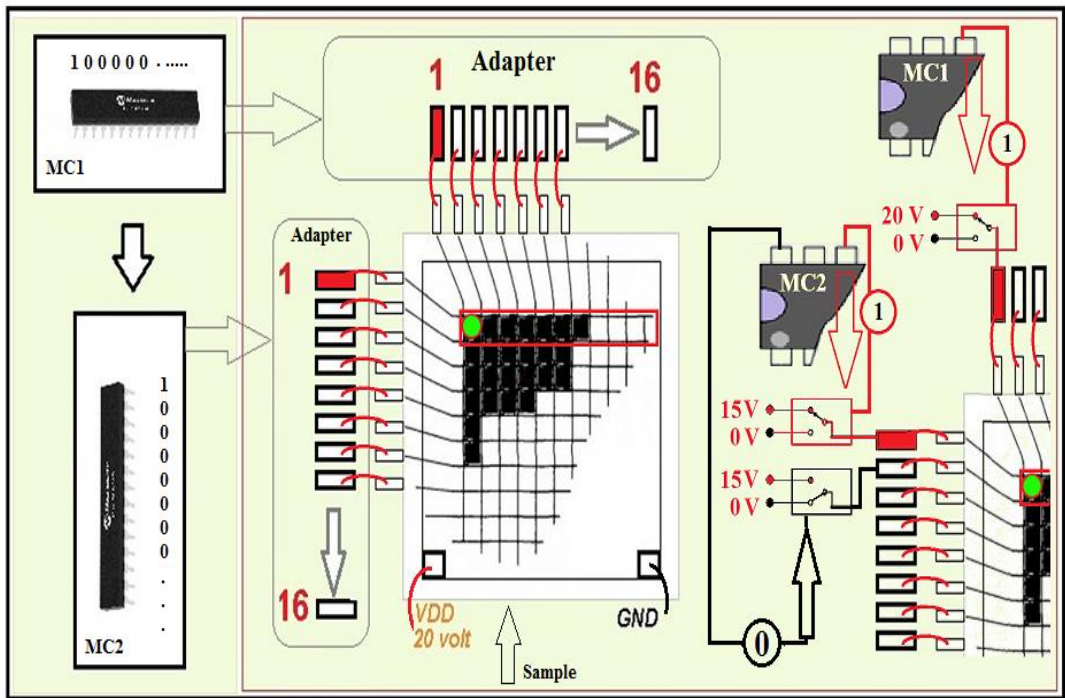
Figure 3.33. How the circuit works.
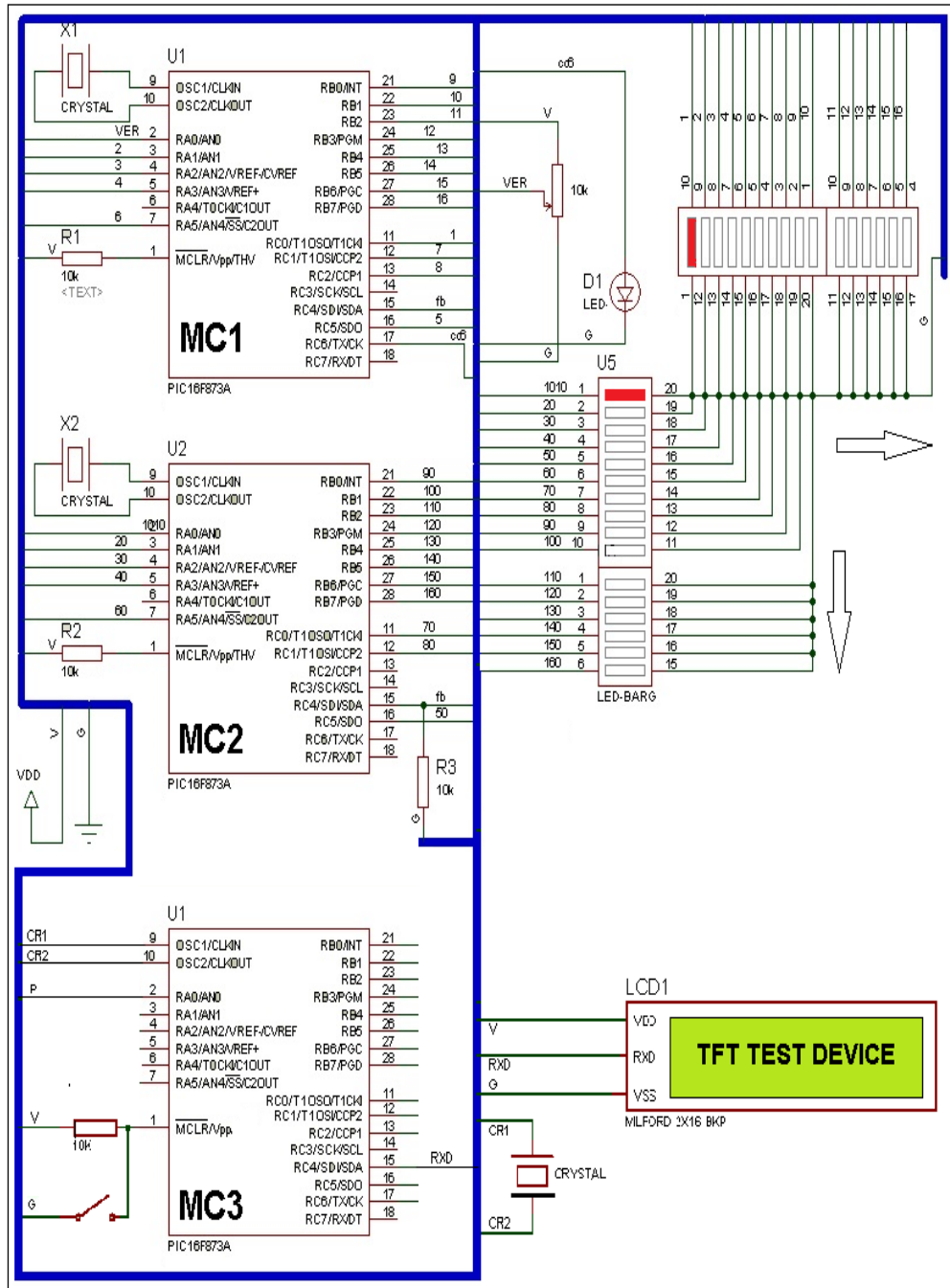
Figure 3.34. Circuit diagram .

3.23. FLOW CHART AND SOFTWARE

Programmable integrated circuits, and we mean here by programmable are that these integrated circuits that do not work directly while connected to the electronic board, as is the case in non-programmable integrated circuits, for this type of integrated circuit to work, it must contain a program written in one of the programming

languages in advance, and this property can use this type to perform various functions according to the commands that were written in the program, and our research we used the controller type PIC16f873A, in fact writing a 16-bit array program, that means the array is 16x16 and that also means that The Matrix will consist of 256 pixels, during the work The Matrix will start counting from 0 to 255. Every Matrix as we know should consist of columns and rows, when we say an 8-bit Matrix, This means that the Matrix consists of 8 columns and 8 rows 8X8, and when we say a 16-bit Matrix, This means that the Matrix consists of 16 columns and 16 rows, which means 16X16 In this research, we used a programmable electronic element, the microcontroller, this electronic element works according to a program written in one of the programming languages of the machine language, so the program must be written and converted to the machine language and uploaded to this processor to perform the function or purpose for which the device was designed. Three processors have been used in this research, which means writing three programs for each program processor and these programs must be strictly synchronized with each other during work, and these programs are shown in the following diagrams Figure 3.35.
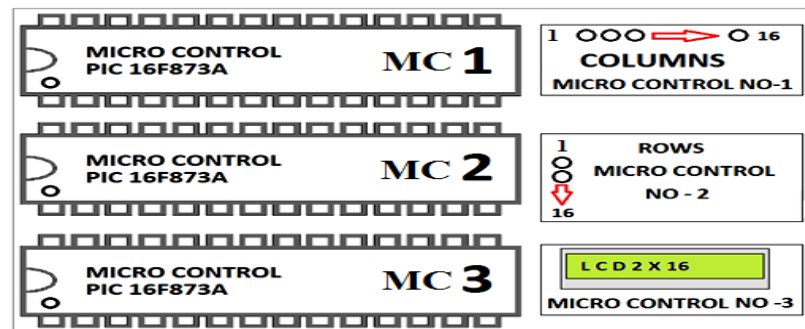
Figure 3.35. Functions of processors in the circuit.

3.24. MICRO CONTROL NO 1

The flowchart below represents the program for the matrix and this chart represents the process of counting columns in the matrix in sequence from (1 to 16) what do we mean by that we mean that when you run the program the micro control will work to count from (1 to 16) and in this program, it will be programmed or specify the ports

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of the processor used as output, that is when the micro control works counting according to the program, below, it will output a logical value of zero or one on the ports that have been specified In the program, the logical value is zero or one, it is the value out on the micro control port, either it is zero volts or 5 volts.
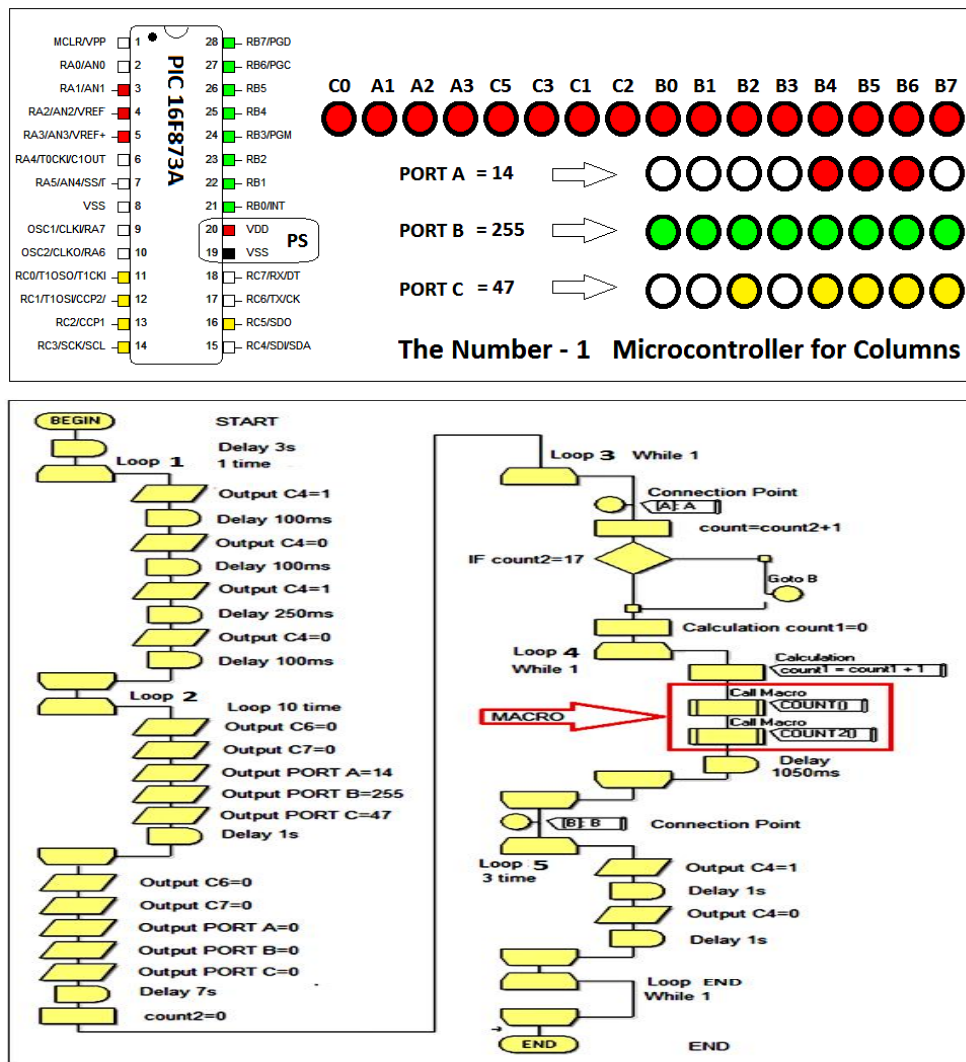
Figure 3.36. Micro control No. 1 Column Counter.

3.24.1. Loop 1

As we mentioned earlier, each matrix consists of columns and rows, and we will work to write a 16-bit matrix program, that creates a matrix consisting of 16 columns and 16 rows, meaning the use of two micro controls, the first for columns and the second for rows, the program was written using the graphical programming program

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flow code V6 The figure below is a flowchart of the column reading program, and this flowchart is part of the complete program, we note at the beginning of the command the symbol that represents the start, as it is known This code is used at the beginning of the formulation of any program and there is also at the end of each program the end symbol, after turning on the device, all the processors that have been programmed will work the program will execute the first command, which is the delay command, and the program will enter with a delay time of 3 seconds It will serve us in the presentation of the welcome introduction in the liquid crystal screen, after that the program will execute the iteration process command and this command will be executed once and then the program will come out to complete its cycle, why once because the repetition has been selected once, and this means that the program will pass this repetition only once And it comes out to complete its remaining cycle in the program, here and as we note in the code below, the program will work to make port (C4) as an output that will be (C4 = 1) for a cycle of time of 100ms and then the program makes port (C4 = 0) with a delay time of 100ms and then makes (C4 = 1) for a cycle of 250ms and then returns to zero for a cycle of 100ms and then the program comes out of the repetition, and the function of this repetition is to issue an intermittent sound to indicate the beginning of the program to work where the (C4) port will be connected to the buzzer to generate sound as shown in the attached picture. As shown in Figure 3.36. and Figure 3.37.
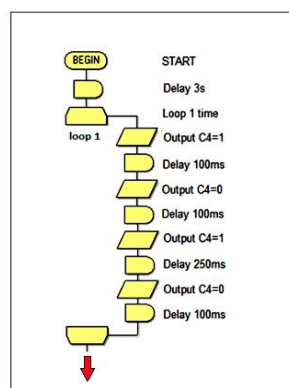
Figure 3.37. Columns-loop1.

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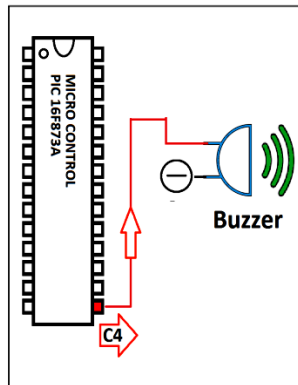
Figure 3.38. Connect buzzer.

3.24.2. Loop 2

After the first loop of iteration is completed, the program passes through the second loop2 of repetition, and in this episode, I programmed the following ports: (port A), (port B), (port C), port A=14 meaning that each of any A1، A2، A3 output logic(1) and port B = 255 and this means B0 =1, B1 =1, B2 =1, B3 =1, B4 =1, B5 =1, B6 =1, B7 =1   and port C =47 meaning C0 =1, C1 =1, C2 =1, C3 =1, C5 =1 and it means All the ports mentioned will have a logical value of 1 and the figure below 3.38. shows the flowchart of the program, while the shell 3.39. below shows the image of the micro control and ports(A، B، C) that will be retained by logic 1 for a cycle of time of 10 seconds That delay due to the repetition that was determined for 10 times for each time a delay time of 1 second, with the beginning of this delay time a message will be displayed on the screen saying (test all pixels), all the ports that have been mentioned will be practically connected to 16 Relays via a photo coupler electronic key, which was explained on the practical side, after this delay time, the program will come out of iteration and continue to complete its remaining cycle to implement the program.
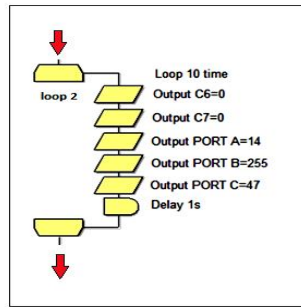
Figure 3.39. Columns-loop2.
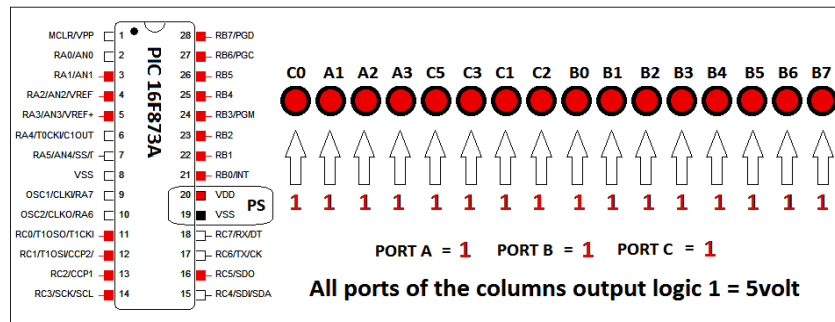
Figure 3.40. Ports of the output of the columns.

After the first loop of repetition was completed by issuing the sound of the start of the program and the second episode in which the ports were selected by taking out logic 1 on the specified ports for a period of time 10 seconds , I programmed the following ports : port A , port B , port C, port A = 0 meaning it will be all of any A1 = 0 A2 = 0, A3 = 0 output logic 0 and port B = 0 and this means B0 = 0, B1 = 0 , B2 =0 , B3 = 0 , B4 = 0, B5 = 0, B6 = 0, B7 =0 and port C = 0 meaning C 0 = 0, C 1 = 0, C 2 = 0, C3 = 0, C5 = 0 and that means all the ports mentioned will have a logical value of (0) and Figure (1-3) shows the steps for identifying ports By taking out a Boolean value of (0) after it was logic (1) , and therefore every relay associated with these ports will stop working, and then put a delay time of 7 seconds Its purpose is to display a message on the liquid crystal display saying (now test the pixels one by one) and the program continues to complete its remaining cycle. After the delay process, I specified a variable named count2 and made the value of this variable (zero) mean count2 = 0, and this means that we have built a variable for a counter whose function we will talk about in the next step.
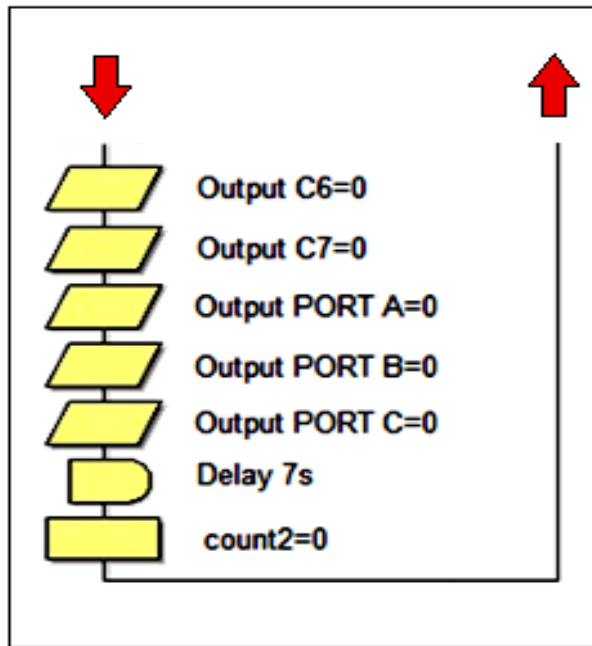
Figure 3.41. Reset ports.
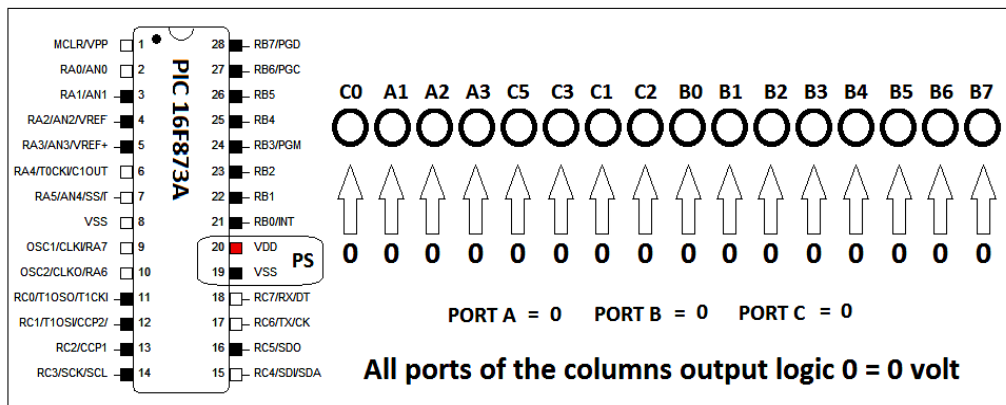
Figure 3.42. All ports Output logic(0).

3.24.3. Loop 3

In this part, we will talk about two important counters in the program, the first counter inside the loop3 and the second counter inside the loop4 for the first counter will count each cycle, after which the second counter inside the loop4, starts counting from (1-16) sequentially. As we know that the column counting program is loaded on micro controller No.1 and in this IC 16 ports have been prepared from it as an output for the columns of the matrix, the second counter in loop4 will output a logical value

of 1 on the 16 ports that you specified in the program and sequentially with a time of 1 second for the work of each port, which represents the columns in the array، at the end of counting each cycle, that is, in the value 16, after counting this value, you specified an exit point from the iteration, the program will exit from the loop4 to the beginning of the loop3 through the connection point A: the first counter will count all loop4 cycles and exit the program if the condition inside it is met when the cycle counter completes the 16th cycle, the condition will be met, The program will exit the loop3 permanently via the connection point B: here the program will have completed counting 16 columns repeated 16 times compatible with the row counter program whose program we will talk about later .
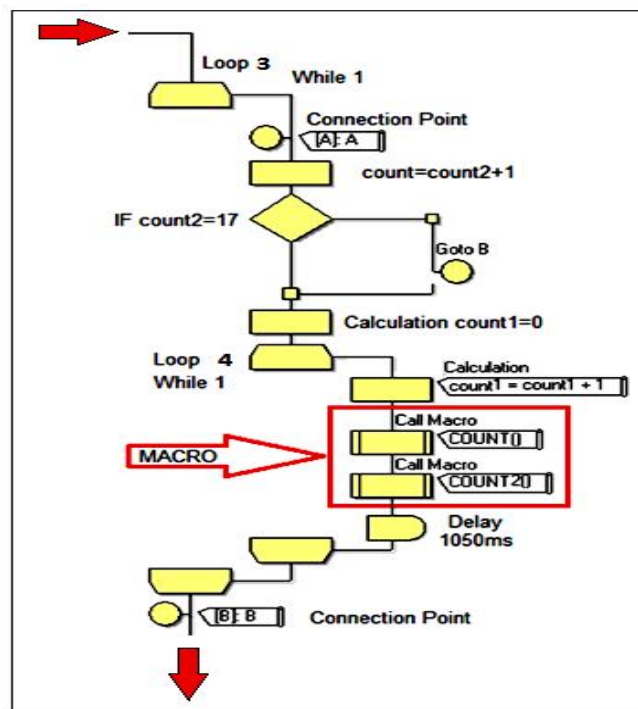
Figure 3.43. Columns-loop 3 and loop 4.
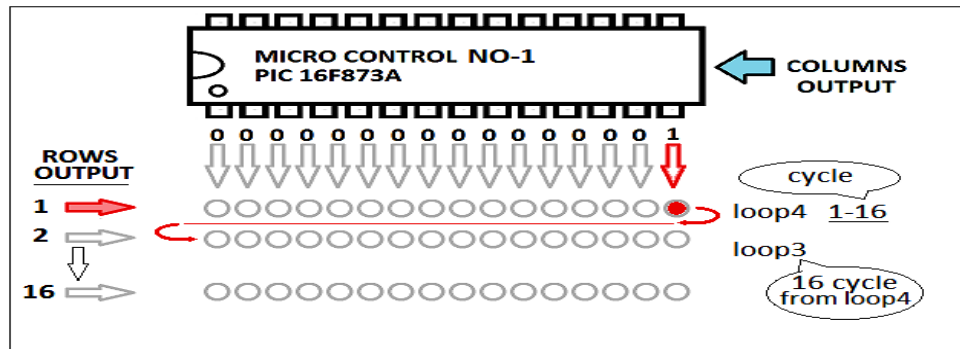
Figure 3.44. Columns Output and count.

3.24.4. Loop4

As I mentioned on the previous page that the function of loop4 is to graduate logic (1) for the micro control exit No. (1) through a counter that works to count the columns that have been specified for the matrix How so, the counter here will work to count the repetitions of loop4 In this loop I specified the counter value count1=0 after that, the program will pass the macro and as shown in the figure below (1-5) and during its passage through the macro, the value of the counter will increase (1) meaning that the counter will read the value of (1) After passing through the macro, it will pass a delay time of 1050ms, then repeat the process, and here the count will increase to become (2) and go through the delay and return to increase (1) so that the value of the counter becomes (3) and so on until the count reaches (16) and here the program will come out of the loop4 to pass the loop3 to change the value of the first counter there to become (2) after it was (1) and then the program returns to enter loop4 to complete the count from (1-16) and then comes out of the loop4 to pass the loop3 to increase the count in it (3) after it was (2) until the loop3(value=16), then there is a condition that will be achieved, and thus the program comes out of the loop3 announcing the end of the program.
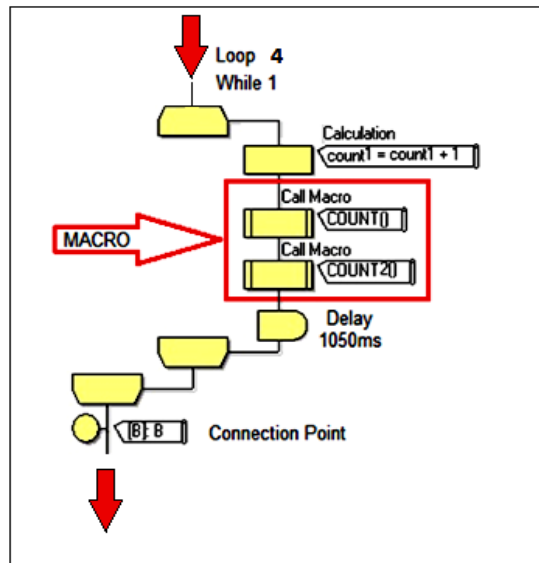
Figure 3.45. Columns and macro.

Inside the macro, there is switch count1 and switch count2, which are subfiles that are called by the program as soon as the program passes through the macro after entering the program in the loop4, the counting process will begin after the value of the counter (0) will increase to become (1) and you will pass by switch count1 It is possible to specify 10 paths by numbers I have specified 8 paths for each path number through which you will determine the entrances or exits of the micro control number (1) that you want to implement while the number or value of the counter matches the value of the path, when the loop4 counter will start with the number (1) and this means that the program will pass the switch count1 And matches the value of the counter with the tracks The value (1) will match the path that carries the number (1) and thus the steps of that path will be carried out and as shown in the figure below (1-5a) here will be the port of column number 1 (C0 = 1) means (C0=5V) and then returns to the value of (C0=0) after a time of 1s after that, the program will exit the switch count1 to pass the meter again, which in turn will increase to count the number (2) and then the program will pass the switch count1 to pass the path No. (2) Here will be the port of column number (2) A1=1 which means A1= 5volt and then return to the value (A1= 0) after a time of 1s after that the program will exit the switch count1 and this process will be repeated with the increase of the value of the meter to pass the rest of the tracks and implement it to the path No. (8) The outputs of the column ports that are specified here are C0 output 1,

A1 output 2, A2 output 3, A3 output 4, C5 output 5, C3 output 6, C1 output 7, C2 output 8 in micro control .
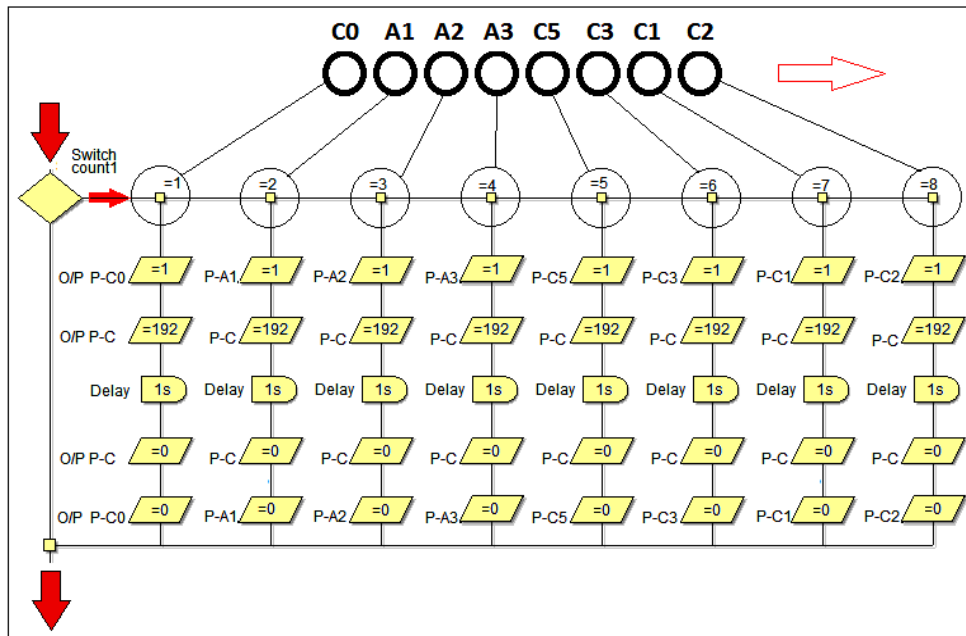
Figure 3.46. Switch count 1-8.

Inside the macro, as we mentioned in the previous flowchart, there is a switch count1, the number two, the difference between them is that the first will be determined the paths of the numbers in it from (1 to 8) and the second will be determined the paths of the numbers in it from (9 to 16), when entering the loop3 program, and as we mentioned earlier, the first counter will record the first loop of repetition, and here the program will continue to work and enter the macro that contains switch count1, the first number of two from (1-8), and the second From (9-16) here the second counter will count (1) and this value will pass the switch count1 with paths from (1 - 8) and as we mentioned earlier in the case of counting the second counter value (9) This means that the program will pass the switch count1 with paths from (9 - 16) This means that the program will pass through path number (9) which in turn will output a logical value (1) on the micro control port B0 means that (B0=5V) during that all ports will be logic (0) means So all ports = 0 volts, then b0 becomes logic(0) after 1s, the program continues to count and turn the ports on

and off sequentially until the count reaches (16) here the port (B7) will output a value (5V) on this port here the port (B7) will output the value of (5V) on this port for a period of 1 second, then it turns off, which becomes 0 volts, and then returns to loop3 through the connection point A: here the meter number 1 will count the value of 17 and this value will pass the condition after the counter, which says if the counter value =17 exits the program through the connection point B: the switch count1 output ports (9 - 16) are B0 output 9, B1 output 10, B2 output 11, B3 output 12, B4 output 13, B5 output 14, B6 output 15, B7 output 16, which are the micro control outputs No.1, which represent the columns of the matrix as shown in the figure below.
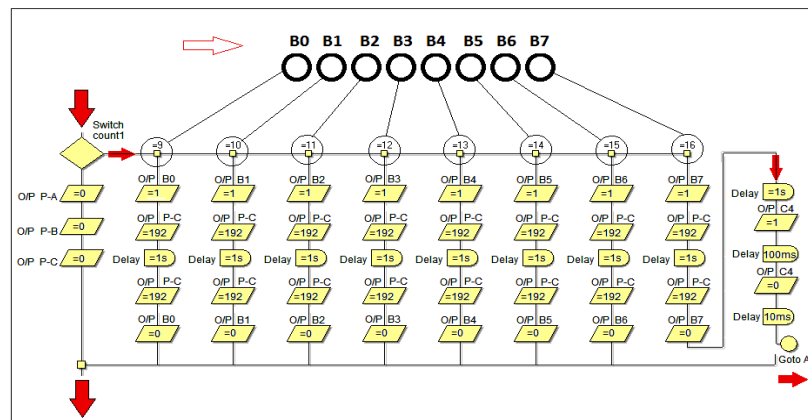
Figure 3.47. Switch count 9-16.

3.24.5. Loop5

After the end of loop3, which counted 16 cycles, each cycle consists of 16 sequential counter readings of (1 - 16) The program will exit the loop3 through the connection point B: It will pass loop5 to end the program we made loop3 repeat 3 times and then exit the program loop5 will make the C4=1 port, meaning that the output of C4=5V will be for a cycle of time of 1s and then return to C4=0V for a cycle of time of 1 second as well This process will be repeated for three times, then the program will come out of the loop5 autonomously, and the c4 will be connected to the buzzer to issue an intermittent sound three times to announce the end of the program and enter the loop end, which is another loop in the program, the program enters here in an

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infinitely closed loop, and here all the exits will be for the micro control No.1=0, the program does not come out of this loop except in the case of turning off and turning on the device or pressing the button to zero the program on the interface device ،here the program of micro control No.1 will have finished counting the columns for an array consisting of 16 columns and 16 rows, and here the micro control No.1 must be synchronized with the work of micro control No.2 after the rows for the program to work correctly. The figure 3.48. below shows the flowchart of loop5 and loop end, and how to connect the buzzer to micro control (No.1) .
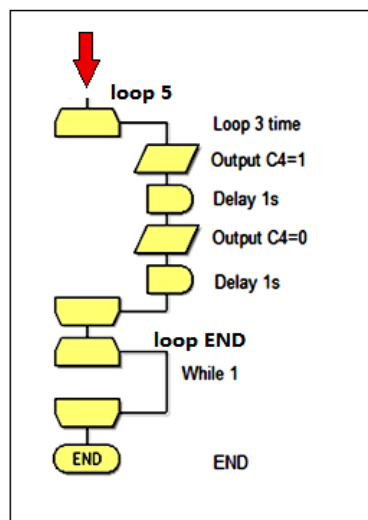
Figure 3.48. Loop 5 and end.
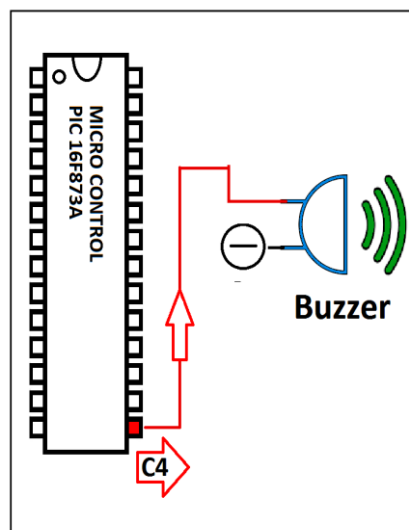
Figure 3.49. Connect buzzer.

3.25. MICRO CONTROL NO 2

Microcontroller No. 2 works on counting the rows of the matrix, and its work depends on microcontroller No. 1 in counting the rows in sequence from (1 to 16), when the device is turned on, microcontroller No. 2 is responsible for counting the rows of the matrix will work by outputting logic 1 on the first port, and thus the first row will be active To count its columns from 1-16. The default boolean value is (0) for all other outputs, and when it is zero, this means that the outputs stop working. In order for the device to work properly and accurately, there must be synchronization between MC1 and MC2. The chart below is 3.50. The represents the matrix and the process of counting the rows in the matrix in sequence from (1 to 16).
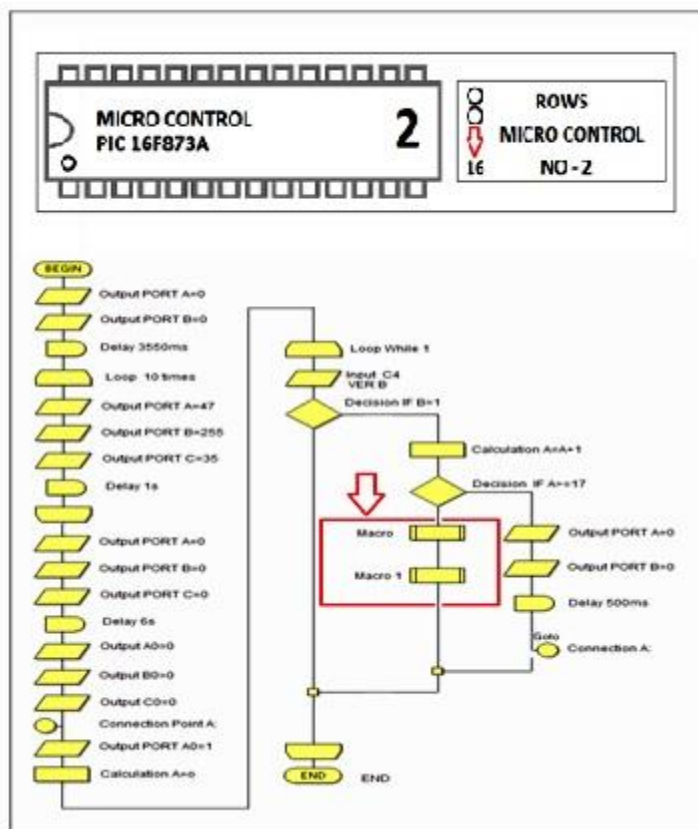
Figure 3.50. Rows counter .

3.25.1. Loop1

As is known at the beginning of each program, there is a beginning, and this start is represented by the icon begin, and there is also at the end of each program and represented by the icon ends At the beginning of accessing the program, we make both the microcontroller port A and B equal to 0 with a delay time of 3550 milliseconds, synchronous with the delay time that was written in the columns program in micro control No.1, and during this time, the welcome message will be displayed on the liquid crystal display within the microcontroller program. No.3, after this delay time, we made a loop1 and inside this loop, we specified the following ports as port output (A0, A1, A2, A3, A5, C0, C1, C5, B0, B1, B2, B3, B4, B5, B6, B7) here we made all these ports of microcontroller No.2 work to output a logical value =1 or in other words, the output of all these ports will be = 5V This output will pass a delay time of 1 second and this will be repeated inside the loop ten times and this means the output of these 5V ports will last for 10 seconds, At the same time, all the outputs of the microcontroller No.1 of the columns will be worth 5V and with a delay time of 10 seconds as well, because as we mentioned earlier, there is a synchronization between Micro control No.1 and micro control No.2 after the end of the loop of its ten cycles, it will come out to complete the rest of the program. As shown in Figure 3.50. and Figure 3.51.
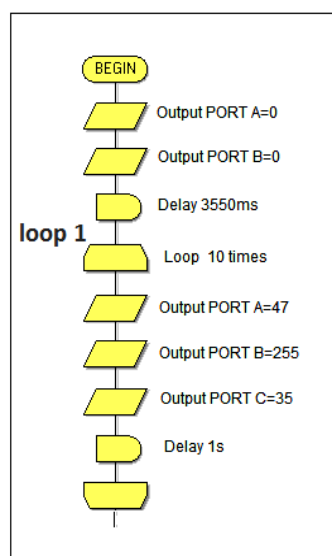
Figure 3.51. Rows – loop 1.

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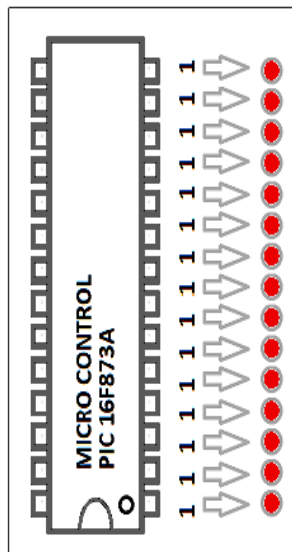
Figure 3.52. MC-1 Output ports logic(1).

After taking out the logic (1) on all output ports of micro control No.2 for the rows of the matrix for a cycle of 10 seconds, synchronized with micro control No.1 for columns, the program will come out of loop1, and here we will make all the outputs equal to (0) as shown in the flowchart below, and then we put a delay time of 6 seconds also synchronized with the micro control No.1 of the columns of the matrix after all ports are equal to logical output =0, which means output=0V, the program will pass through a connection point, which is point A this point is a return or return point from the loop2 after fulfilling the condition in it, which is to complete the counting of cycles consisting of 16 cycles and will be mentioned in the loop2, and then we made the port A0=1 synchronous with the micro control No.1, which will start counting the columns of the first row only, why only the first row because all the micro control exits will be No.2 =0, only A0=1, this means that the first row will only be effective after that we make the value of the loop2 counter A=0 and after completing the counting of this cycle, the number will shift to the second row, due to the increase in the value of the loop2 counter ‹the process continues until the meter reaches port 16. As shown in Figure 3.52. and Figure 3.53.
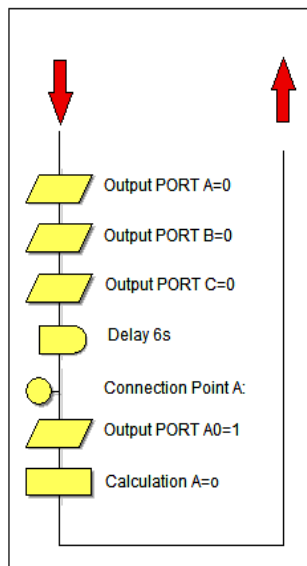
Figure 3.53. Reset port a,b,c.
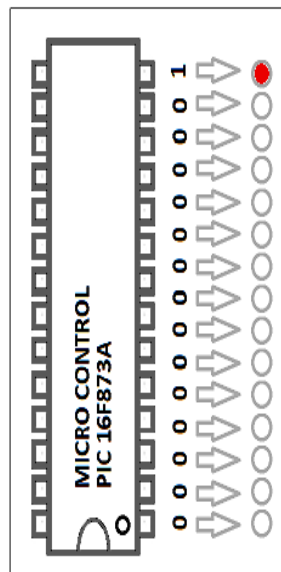
Figure 3.54. MC-1 Output ports logic (0).

3.25.2. Loop2

After we created a variable with a value of zero A=0 before the loop2, the program will enter the loop2, and here we have specified port C4 as input with a variable named (B) This variable will work as a key if it becomes (1) it will achieve a condition and pass the condition, and if (0) will ignore the condition and continue to

complete the program, and that this variable receives logic (1) from the micro control No.1 of the columns, at the end of counting column 16, logic (1) is sent to the micro control No.2 to the entry port C4 to change the state, so we put after the entry port this condition, which is (if B = 1) means that going to a counter that works to increase the count of variable A for 16 paths that pass them sequentially from 1 to 16 in each path will occupy Port and this will be inside the macro shown in the figure below, and here I put another condition by the program and this condition is (if A>=17), that is, if the number of cycles becomes 17, the condition is achieved, which is to minimize port A and since B and exit To count again after a delay of 500 milliseconds, and then we will talk about macro. As shown in Figure 3.55.
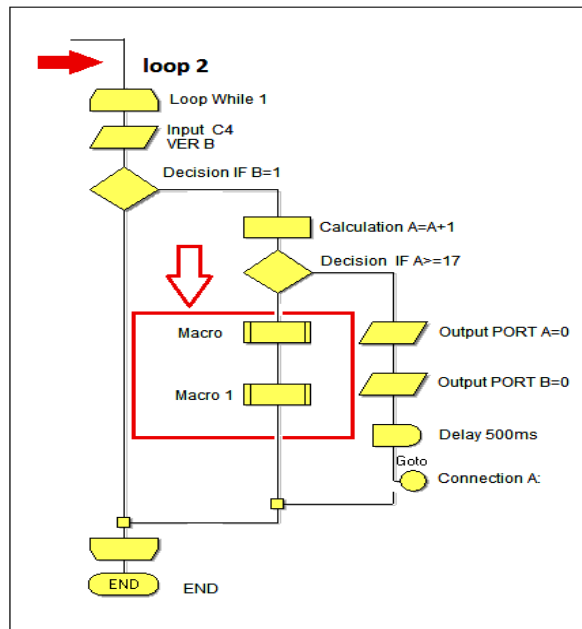
Figure 3.55. Loop2 and macro.

3.25.3. Macro rows switch 1

In the loop2, as we talked about earlier, there is counter A, this counter will work after the content of both macro and macro1 Here we will talk about macro, the macro has switch A inside it, and this contains paths number 8, it numbers start from (1 - 8), so each cycle will pass the value of the counter with this switch A, so if the counter carries the number (1), this means that it will pass through path No. (1) and apply the commands inside this path, and here in this path we have made Port A0=1, and the

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rest of the ports will be (0), then the program returns inside the loop and passes the counter again and the value of the counter will increase to (2) and it will pass through path No.2 and implement what is inside it, which is to make A0=0 and after a time of 500 milliseconds makes port A1=1 and the rest of the ports (0), and the loop continues to count, output and implement what is inside the tracks upon completion of the value number 8 of the counter, the program will turn to achieve the rest of the paths inside the macro1, in macro1, which contains inside it the switch A2, which contains inside it the paths from (9 - 16). As shown in Figure 3.56.
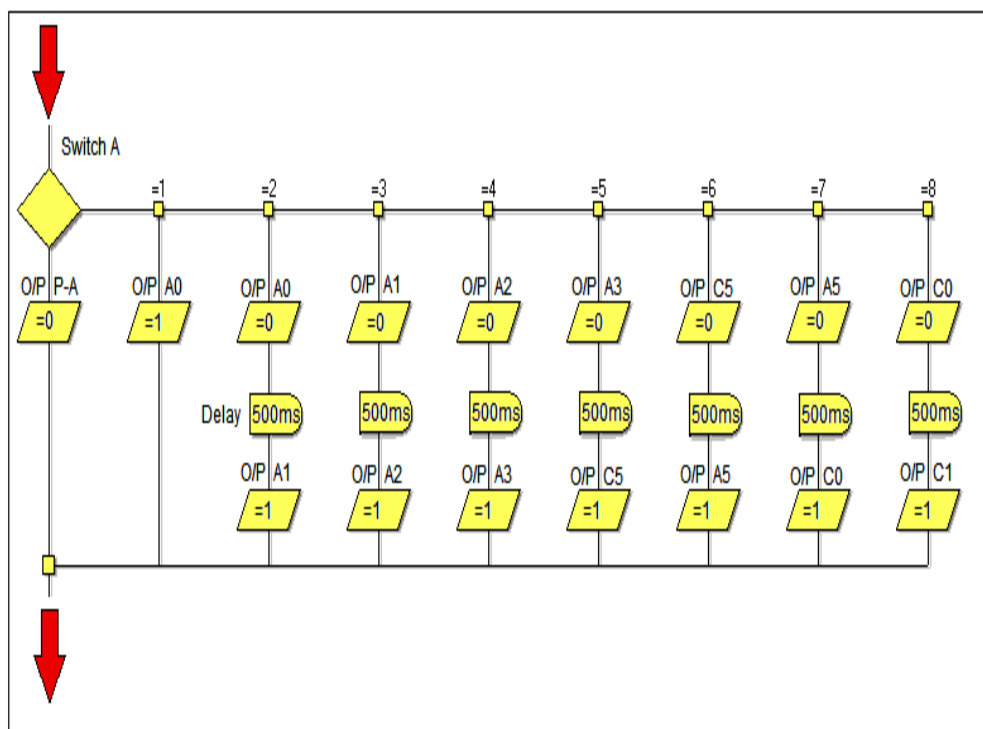
Figure 3.56. Switch A 1-8.

3.25.4. Macro ROW switch2

After the switch A paths have been completed, which are the tracks from (1-8), that is, when the meter value passes through the path (8), we will output a numeric value (0) on all the micro control exits No.2 after the rows, and the logic value (1) will be only on the port (C1) located in the eighth track (8), here when the counter increases to the value (9), the program will pass through the second switch A, which contains the paths from (9-16) and it will pass through the path No. (9) to achieve what is

inside it This means that all the output ports of the microcontrol will be No. (2) for rows (0) except for port B0=1, which is the port of track No. (9), the program will continue counting inside the loop until the completion of the counting track (16), as we know the loop will continue to repeat and here the value of the counter will increase to the number (17) and this means that the counter has been repeated (16) times, so it must now exit and here we put the condition (if A >= 17) This condition means if the value of the meter becomes greater or equal to (17) Exit of loop2 after zeroing both port A and port B with a delay time of 500 ms. As shown in Figure 3.57.
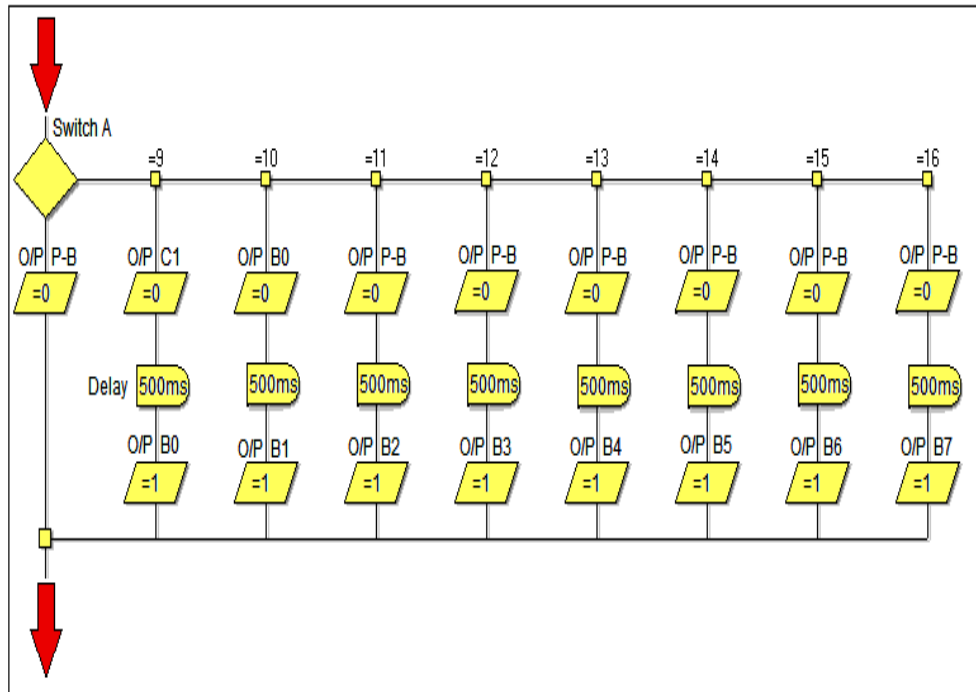
Figure 3.57. Switch A 9-16.

3.26. MICRO CONTROL NO 3

After the columns and rows program is completed, a program has been prepared that works to show the counter values for the columns and rows and show the location that the matrix count reached as a number, where programmed Microcontrol No.3, which will work to operate the liquid crystal display and the figure below 3.58. represents the flowchart of the screen driver.
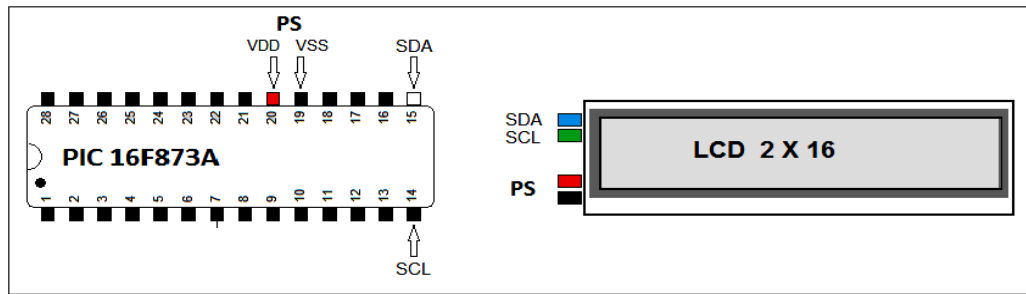
Figure 3.58. Liquid crystal display connection.
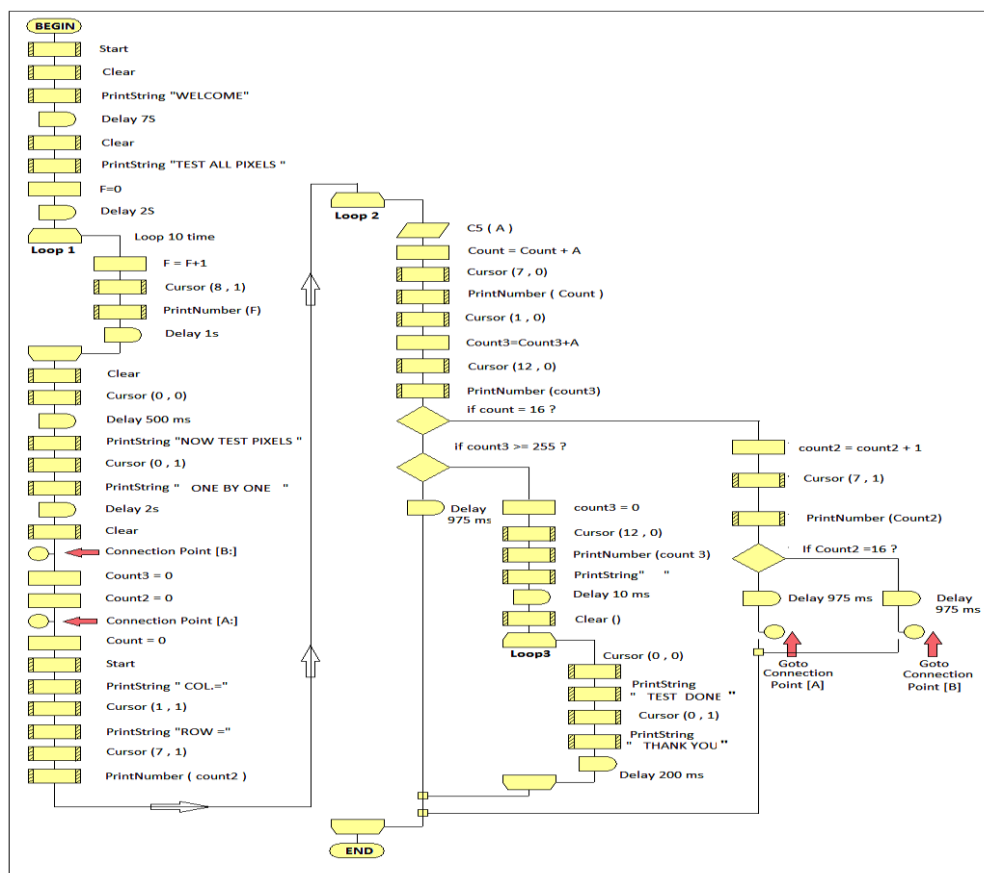
Figure 3.59. Flow chart- liquid crystal display .

Each program, as we know, contains a beginning and an end icon, we will start the program with a definition of the liquid crystal display(LCD) using the start command that we have already talked about, the work of this screen will be linked to the micro control No.3 and this micro control will be synchronized with the work of both micro control No.1 for columns and micro control No.2 for rows, the function

of this micro control is to show the numeric value of both the column counter and the row counter and show the operations messages of the matrix. After defining the screen, we erase the data that may appear randomly during operation by the clear command, and to show the welcome message, we put the printstring command and write 'welcome' and then put the delay command for a cycle of 7 seconds here this message will appear on the liquid crystal display (LCD) for a cycle of 7 seconds and will be deleted after the clear command and with the printstring command we will write again the message " test all pixels " after that we put a value of zero F=0 for the loop1 counter this message will continue for 2 seconds before entering the loop1, during this period, the output of columns and rows = 0 mean that the logical output will be (0) for all ports that are specified as the output of the array. And here I added loop1 which will be repeated ten times with a delay time of 1 second per cycle, which means that the total delay time will be 10 seconds, synchronizing with the time of column and row counters I added a counter inside the loop1 the value of the counter increases 1 for each cycle, and using the command cursor (8, 1) I specified where to display the count value on the liquid crystal display (LCD), and while entering the program in loop1, all column and row exits = logic (1) means that all ports will have an output of 5V During the exit of the program from the loop1, all the ports of the array for the columns and rows will be zero, and the program will continue to complete its work. As shown in Figure 3.60.
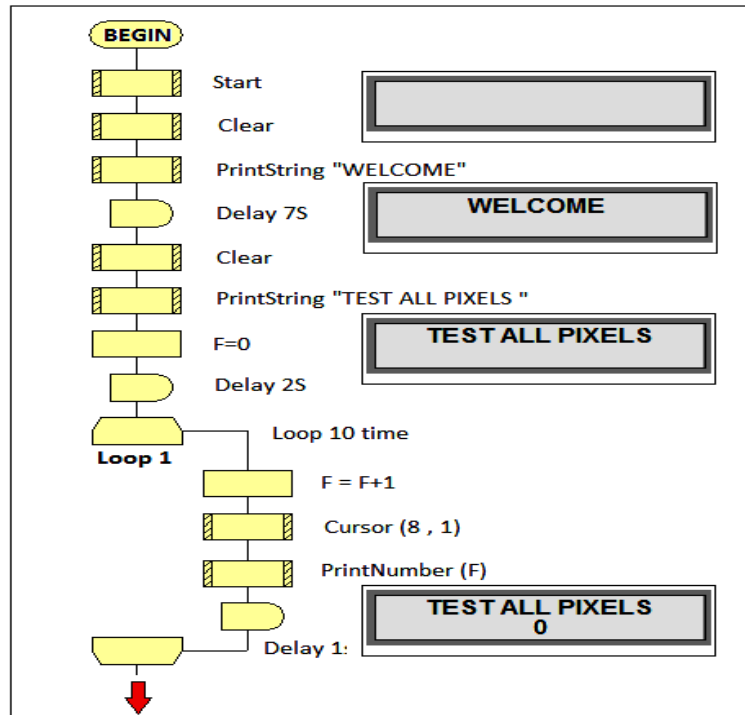
Figure 3.60. LCD start and loop1.

After the program exited the loop1, the clear command was placed for the purpose of erasing all the information of the liquid crystal display (LCD), and as we can see in the figure below, and then a delay time of 500 milliseconds was added, and after this delay time, the message was written by the printstring command "Now Test Pixels" and then the writing points on the screen were located with the command cursor (0 , 1), which means in the first row of the screen, and in the second row, "one by one" was written, and here when the program passes the above steps, it will appear The message is complete on the screen and continues to appear for a period of 2 seconds and then disappears, due to adding a delay time of 2 seconds and adding the clear command to erase the message from the entire screen, and then a return point was added from the loop2, which is connection point [B:] which is in if the count of the counter is completed to 16 and we will talk about that in the loop2, then the initialization will be done to make two enumerators count2 and count3, then we will pass through the hotspot connection point [A:] It is due from loop2, and then we work to initialize a third count and then we work on writing the phrases "COL.="and " ROW =" means columns and rows, and the two statements will be constant until the count is completed. As shown in Figure 3.61.
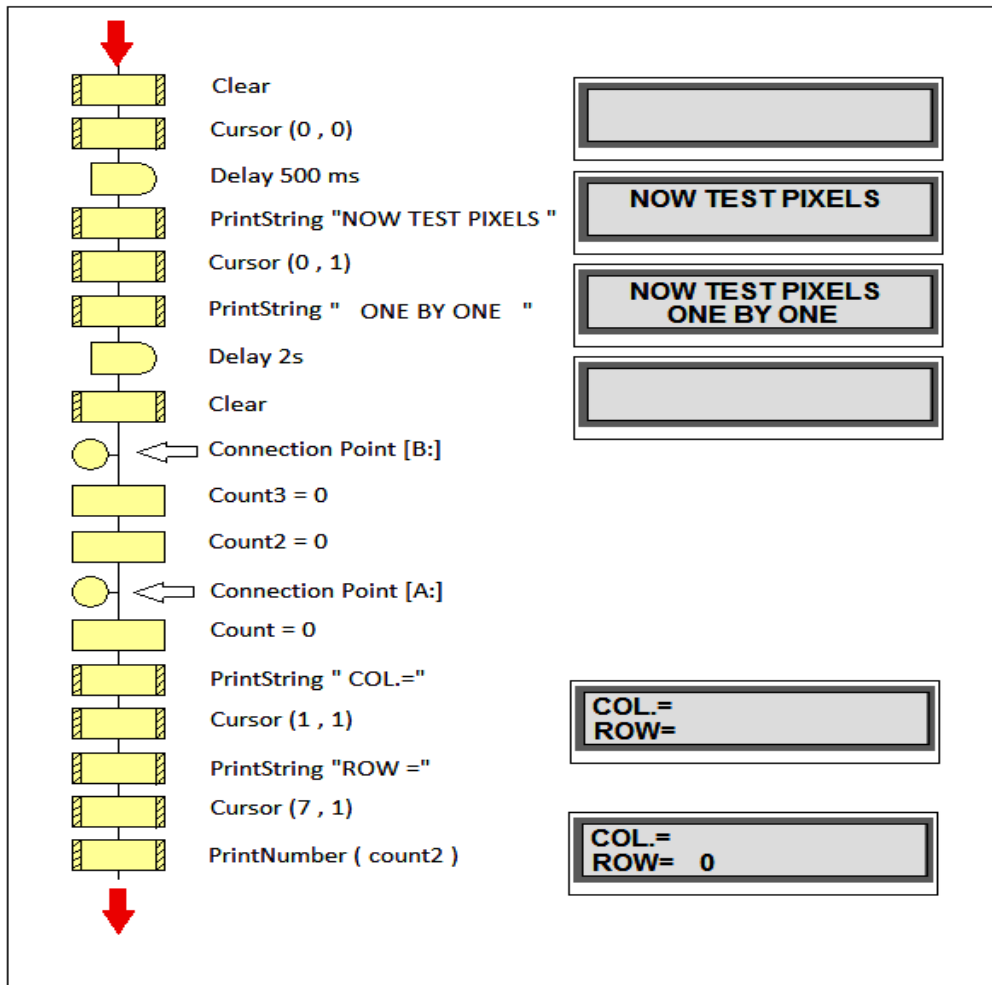
Figure 3.61. Liquid crystal display messages.

In loop2, three counters were made, the first counter will count columns from (1 to 16) in the liquid crystal screen, the second counter will count rows from (1 to 16) in the liquid crystal screen, and the third counter will count the matrix sequentially from (1 to 255) and the meter values will be displayed in the form of numbers on the liquid crystal screen, the idea of making the first and second enumerators here is when the first counter ends After columns from (1-16) the row counter will prepare the first cycle, meaning that it will be (COL .=1) and (ROW = 1) and the figure below It represents the flowchart of the program, the program will enter loop2 in which (C5) entry port has been selected, from this port will enter the pulses coming from the micro control No.1 after the columns of the matrix and these pulses are essential in the work of the three counters, and at the same time these pulses will enter the row counter located in the micro control No.2 through the port (C4) to

count the rows in sequence from (1 - 16), when the micro control No.1 after the first column will send this pulse to both MC2 and MC3, MC2 will receive the pulse via port (C4) While MC3 will receive the pulse through the port (C5) with a variable named (A), the pulse will enter the meter (count) and this meter is special after the columns in the liquid crystal display (count=count+A) After counting, we will determine where the number (count value) is displayed on the screen (cursor (7, 0)) and then print the number to be displayed on the screen using the printnumber command (count))) and then the matrix is counted using the command (count3=count3+A) and the place of display of the number is determined on the screen by command (cursor (12, 0)) then the value of the number is printed and displayed on the screen with the command printnumber (count3))) and the number will be from (1-255) here the program will pass two conditions, the first condition is (if count=16) and the second condition (if count3>=255) the first condition is dependent on the column counter The second condition is dependent on the matrix counter if the first and second conditions are not met, the counts (count) and (count3) will continue counting and displaying the counting numbers on the screen with a delay time of 975 milliseconds because it will pass in the matter delay as shown in the figure below, but if the first condition is met, it means that the counter (count=16) and here the program will pass the row counter (count2) to change its value from (1 to 2) I mean if each cycle of columns is counted, this condition will be met to change The value of the row counter number in the liquid crystal screen, in the way of this counter another condition was added It is (if count2=16) if the condition is not met, the program will exit through a cycle connection pointA: With a delay time of 975 milliseconds in order to complete the work of the meter, and if this condition is met, the program will come out through (connection point B:) With a delay time of 975 milliseconds, this means that the counting of rows has been completed (16) and the value of the counter has become (count3=255) and here the second condition will be achieved (if count3 >=255) and the program will work to zero the counters and erase the screen data and enter loop3 and here the message will be written (TEST DONE) in the first line of the screen and (THANK YOU) in the second line of the screen and the program continues with this loop3 and did not come out of it unless the device was zeroed by a key located in the interface of the device Or by turning off and turning on the device. As shown in Figure 3.62.

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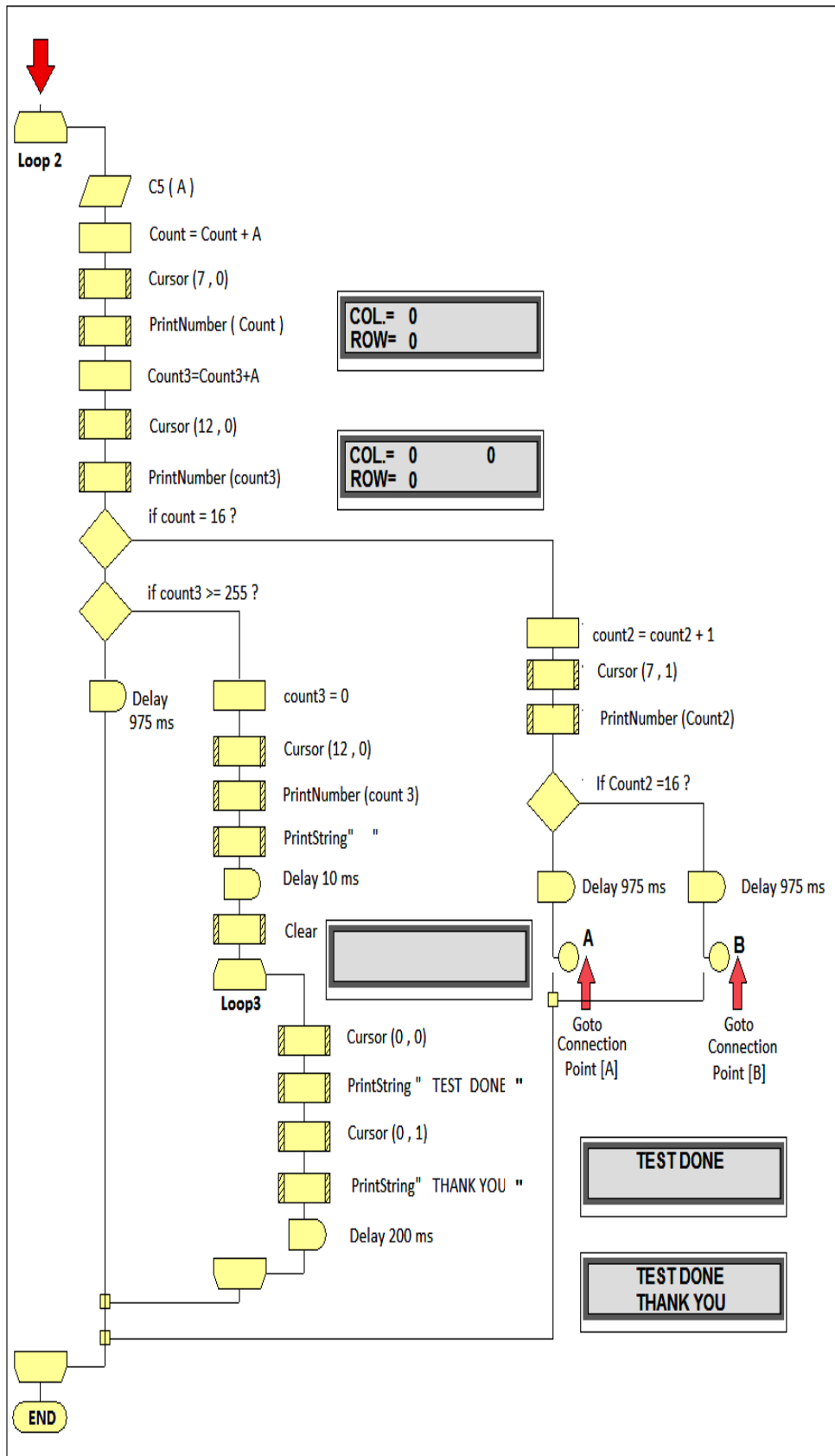
Figure 3.62. Liquid crystal display loop2.

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CHAPTER 4

IMPROVEMENTS FOR FAST TESTING OF PIXEL ARRAYS

In this research, the device that preceded it was designed and we talked about its work in detail, as we know that its main function is to test the TFT samples of x-ray radiographs. These samples are tested by seeing the work of pixels by a camera placed in the device under the platform in the mechanical part because it is not possible to see the work of pixels clearly because of their small size, so this camera was added for the purpose of seeing the work of pixels clearly by mobile or computer.

4.1. METHODS THAT CAN BE APPLIED TO DEVELOP THE DEVICE

4.2. THE FIRST PROPOSAL

Designing an interface on a computer screen and this interface is a set of light-emitting diodes arranged in the form of a matrix consisting of 256 LEDs, which means that this matrix consists of 16 columns and 16 rows and this Matrix works synchronously with the work of the sample Tester device, Labvie will be used in the design of this interface and in order to link the sample tester with the computer, you must use one of the linking tools or connecting devices to the computer, you can use the DAQ USB 6008/6009 or use the Arduino Mega2560, this device will be used as a data input unit for the computer receives signals from the tester by DAQ or the Arduino and sends it to the computer by a USB cable The figure below shows the program interface.
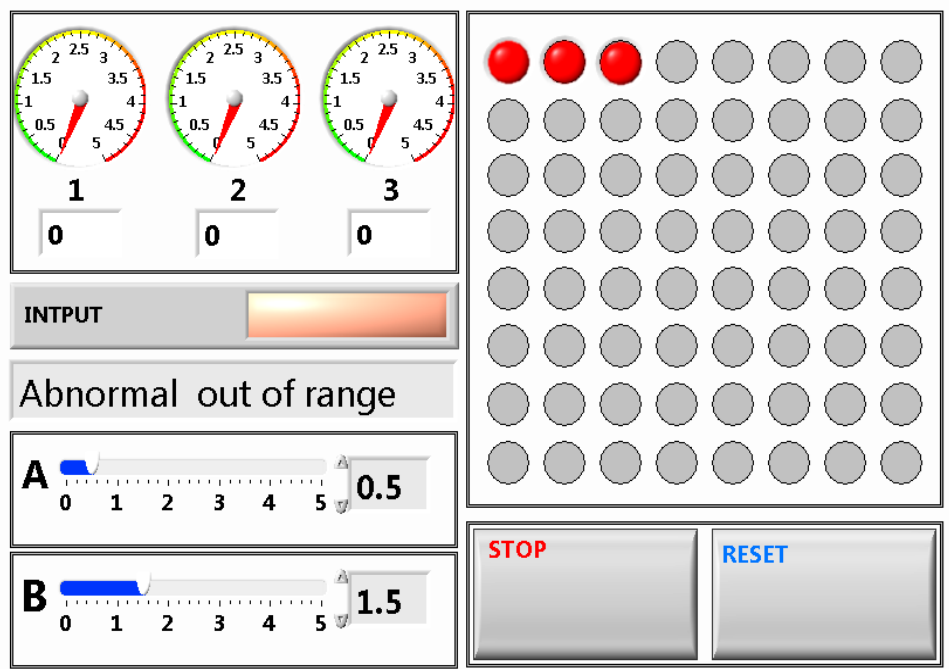
Figure 4.1. User interface by Labview.

4.3. DEFINITION OF DAQ

It is a physical component made by the National instrument software company and manufacturer of the Labview program, and the DAQ is one of the important devices that work with the Labview program. this electronic unit can measure voltages and electric currents or read and measure temperature, humidity, distances, light intensity, and pressure using physical sensors that connect with this electronic unit, this unit is considered a link between the environment and the computer or between the machine and the computer, for example, when we want to measure temperature or measure voltage or current using a computer, we must first, design an interface on the computer to read these values using a program The Labview in this program a program will be prepared for this purpose and through this program the DAQ ports will be prepared that will be used, the signals coming from the sensors associated with the DAQ are analog, which means that the computer cannot handle them, and here the DAQ will convert them into digital signals that the computer can handle and show the results and figure 4.2. shows this. The LabVIEW program with the DAQ will provide us with reading accuracy, flexibility of working, and speed of showing results [32][33].
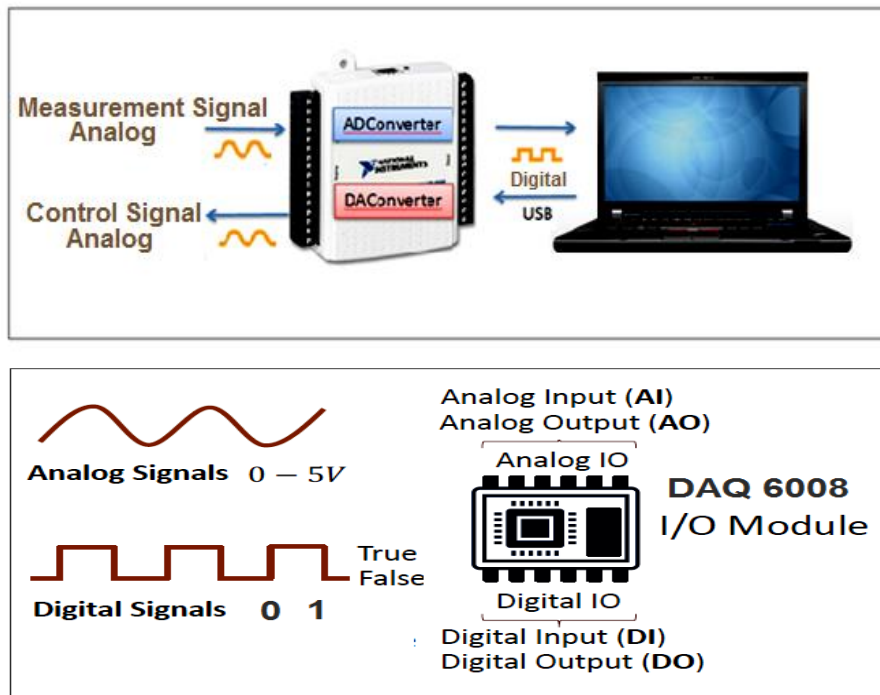
Figure 4.2. AD & DA Converters [30].

4.4. METHOD TO CONNECT DAQ 6008/6009 AND ARDUINO

The method of connecting the DAQ module to the computer via a USB cable as well as an Arduino board, figure 4.3. and Figure 4.4. show this.
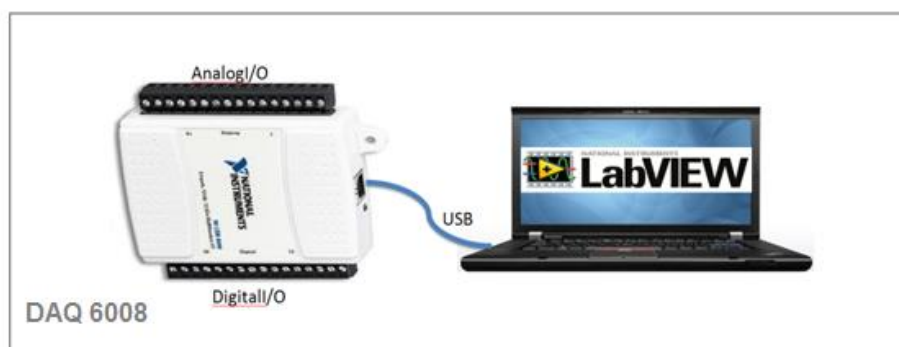
Figure 4.3. DAQ NI USB-6008/ & Labview.
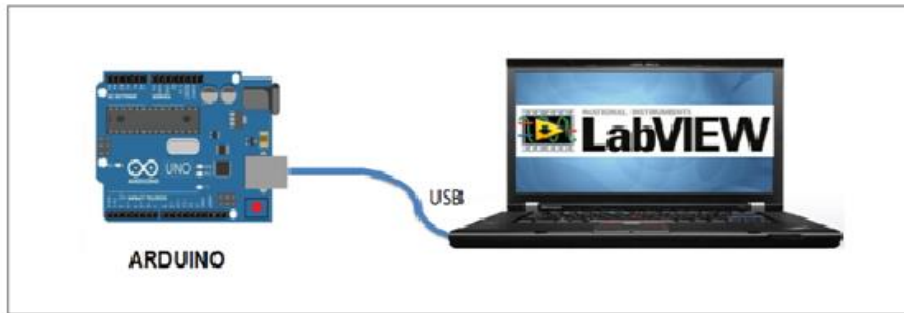
Figure 4.4. Arduino usb & Labview.

4.5. I/O Connector DAQ 6008/6009

Module	Terminal	Signal
	17	P0.0
	18	P0.1
	19	P0.2
	20	P0.3
	21	P0.4
	22	P0.5
	23	P0 6
	24	P0.7
	25	P1.0
	26	P1.1
	27	P1.2
	28	P1.3
	29	PFI 0
	30	+2.5 V
	31	+5 V
	32	GND
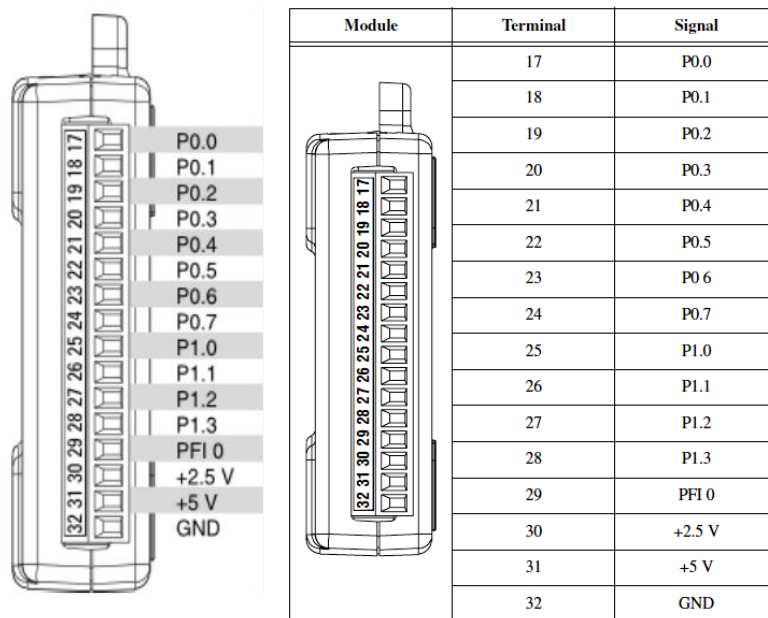
Figure 4.5. Digital Terminal Assignments.

The NI USB-6008 provides basic DAQ functionality for applications such as simple data logging, portable measurements, and academic lab experiments. It is affordable for student use but powerful enough for more sophisticated measurement applications the USB-6008 with the included ready-to-run data logger software to begin taking basic measurements in minutes, or program using NI LabVIEW or C and the included NI- DAQ mx Base measurement services software for a custom measurement.

Module	Terminal	Signal, Single-Ended Mode	Signal, Differential Mode
	1	GND	GND
	2	AI 0	AI 0+
	3	AI 4	AI 0–
	4	GND	GND
	5	AI 1	AI 1+
	6	AI 5	AI 1–
	7	GND	GND
	8	AI 2	AI 2+
	9	AI 6	AI 2–
	10	GND	GND
	11	AI 3	AI 3+
	12	AI 7	AI 3–
	13	GND	GND
	14	AO 0	AO 0
	15	AO 1	AO 1
	16	GND	GND
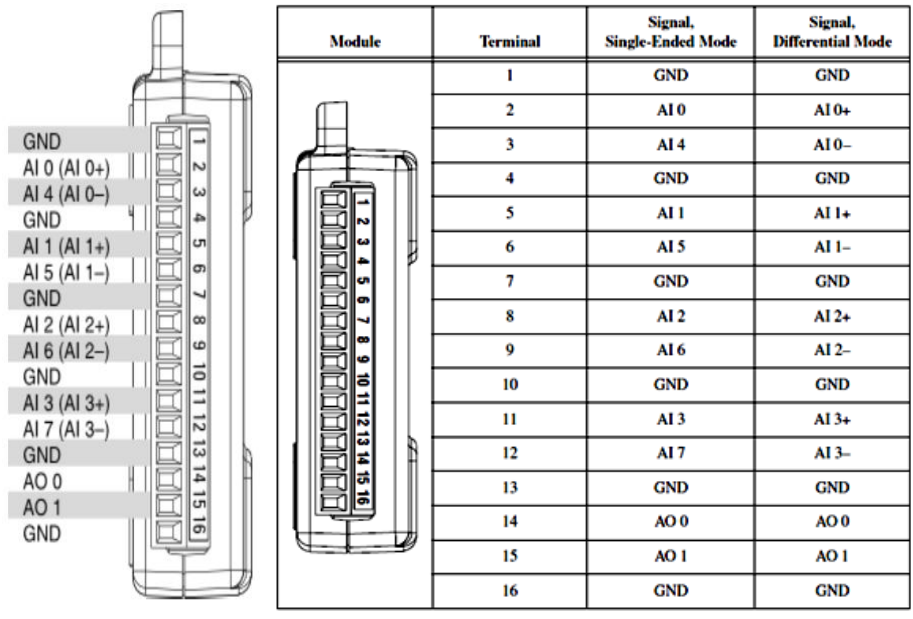
Figure 4.6. Analog Terminal Assignments.

4.6. WORKING PRINCIPLE OF THE DEVICE

The designed device sends signals to the computer via a special cable for this purpose, where data is sent and received between the device and the computer via this four-wire cable The first and fourth wires are the positive pole (5 volts) and the negative pole (0 volts) As for the second and third wires, their function is to send and receive data, the program works to receive signals from the device to display the status of the sample after comparing it within the program with the values specified by the program interface, for example, The value A is the lowest value and the value c is the highest value If the value coming from the tester is less than the value specified by the interface, it means that the pixel number 2 If the next signal is between the lowest and highest value, that is, it is between A and C, it means that the pixel number 3 on the interface lights up green, Which means that the pixel is a number. 3 In good condition is not damaged and the process continues until the last pixel which is the number 256 of the matrix, after completing the work, the program will keep a copy of the glowing valve test image Green glowing diodes represent working pixels and red glowing diodes mean that they are not working and this is one of the proposed ways in which the researcher will be able to develop this device. The figure 4.7. shows this.
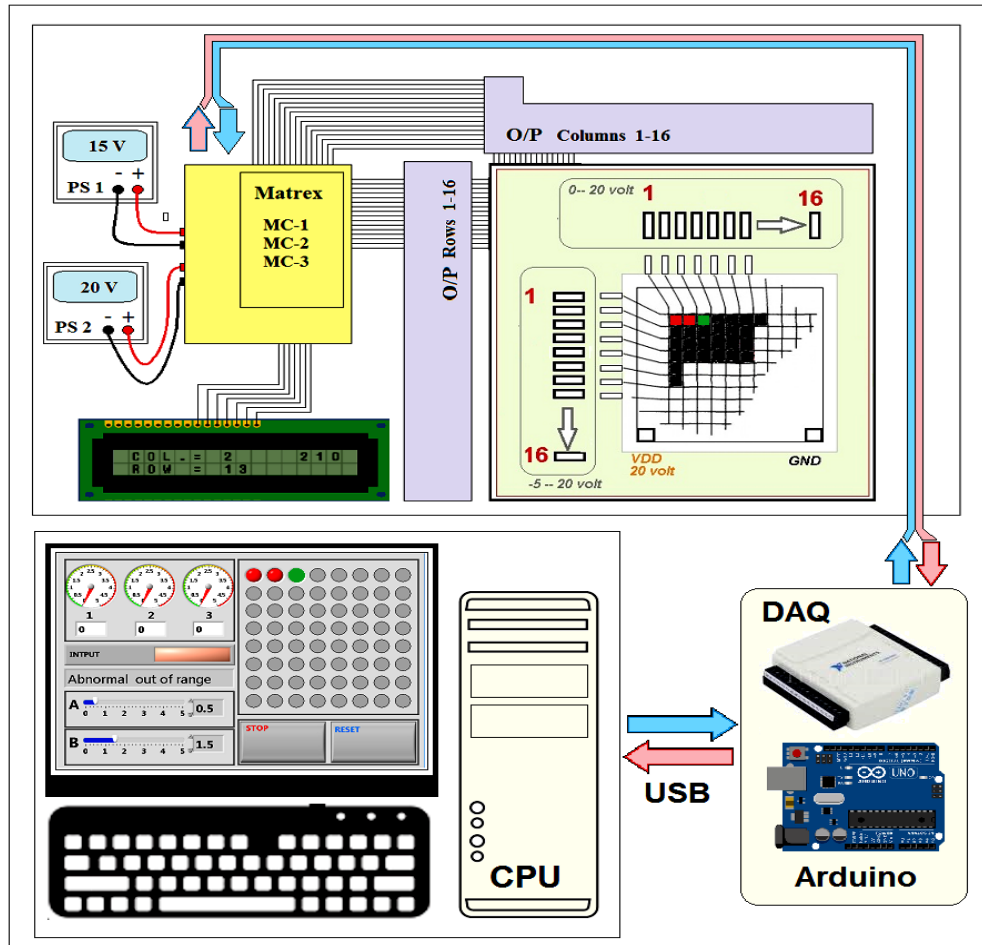
Figure 4.7. Model (A) for testing the TFT sample.

4.7. ARDUINO

Arduino is a set of electronic elements assembled on a PCB card and contains a programmable processor of the mega2560 type through Arduino you can control devices, and machines, and design and implement smart electronic circuits through it, the processor inside the Arduino mega2560 contains many ports through which any project can be implemented, as it contains analog and digital ports and through programming it is possible to determine the work of the port input or output, it is small and easy to use it is easily programmable by the USB port [35][36].

And the Arduino can be used in this search as a link between the computer and the device, it is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software or IDE (Integrated Development

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Environment) that runs on your computer, used to write and upload computer code to the physical board. Arduino Mega 2560 is a successor board of Arduino Mega, it is dedicated to applications and projects that require large number of input output pins and the use cases which need high processing power. The Arduino® Mega 2560 comes with a much larger set of IOs when we compare it with traditional Uno board considering the form factor of both the boards.
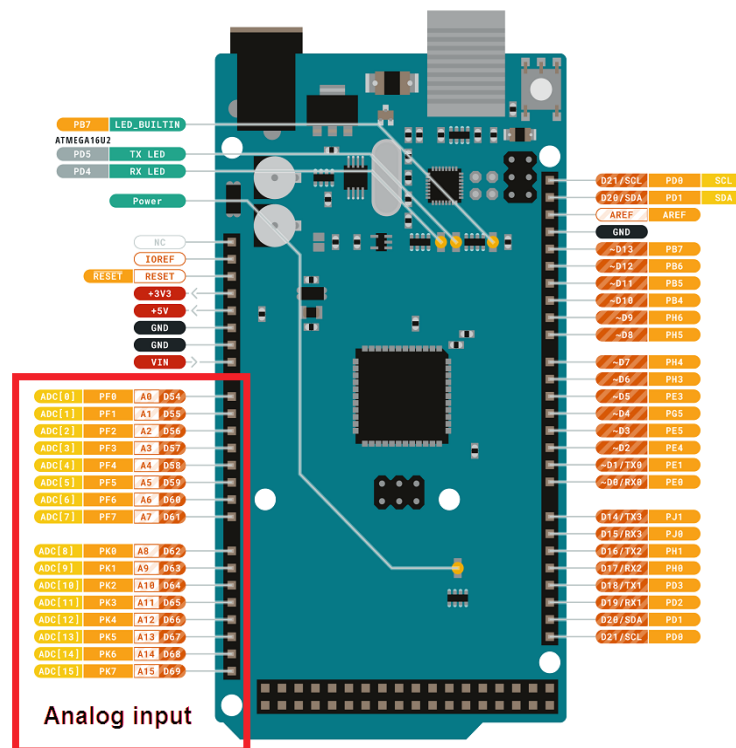
Figure 4.8. Arduino Mega2560 REV.

4.8. IMPORTANCE OF USING ARDUINO MEGA 2560

All Arduino cards are programmable, and these cards differ in memory, type of processor, and number of ports. The ARDUINO MEGA2560 card contains 54 pins for digital input and output, as well as 16 pins for analog input, and this makes it unique in use.

4.9. THE SECOND PROPOSAL

The second proposal is to manufacture a sample similar to the sample to be tested, but this sample contains an array consisting of optical transistors so that in the test case the sample to be tested is placed symmetrically above the new sample so that the pixels are parallel, Pixel 1 for the sample to be tested above Pixel 1 for the sample of optical transistors and Pixel 256 above Pixel 256 for the sample of optical transistor, through this we will read the data of the sample under test, the sample that will be at the top, which will be tested at the top, and which will be tested at the top of the the sample, which will be tested at the top of the sample, which will be tested at The upper part of the sample., While the sample that will be less than the sample to be tested will be read-only, as the transistor Matrix sample will send signals to DAQ or Arduino Mega2560 for the purpose of converting them into digital signals so that the computer can handle them and show the results on the program interface, so the principle of operation of this proposal will be similar to the principle of operation of the photo coupler and figure 4.9. shows that.
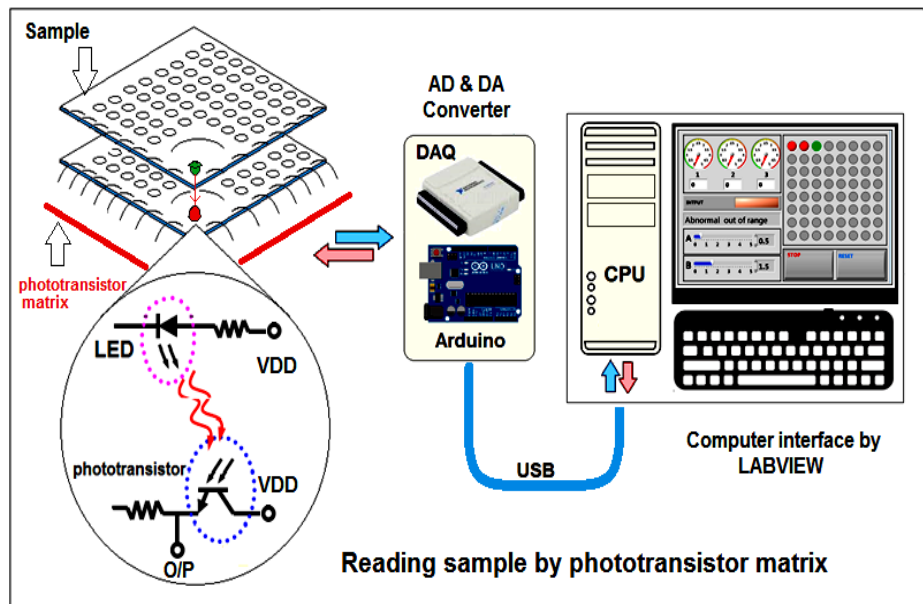
Figure 4.9. Photodiode and phototransistor.

CHAPTER 5

SUMMARY

This paper discusses the design and operation of a device for testing TFT samples used in X-ray machines. The TFT samples are small in size and precise to manufacture as they are made under special conditions. The details of this sample can not be seen with the naked eye. Therefore, this device is designed and implemented for the purpose of knowing the suitability of the sample for work after manufacturing. This device used three microprocessors of the microcontroller, PIC16F873 type, and a PCB Printed circuit board. Install various electronic elements and components on this panel to automate the testing process. Automation is the basic process in the design of the test device. The goal of the automation process is for the device to work autonomously. The device is powered by lithium-ion batteries with a capacity of 7.4 volts, which are used to power electronic elements. A battery charger is also included to recharge the batteries when their power is low. , this battery is characterized by high capacity and   long life and it is rechargeable. Other electronic elements such as a switch, LED – relays – photo coupler, and other auxiliary elements were used to operate the device. And a mechanical part of a used microscope was used in this device, this mechanical part contains from the first two stages it will be fixed ‹As for the fixed platform, the Adapter will be installed on it, and its location will be at the top and the moving platform will be installed on the sample to be tested. The Adapter consists of two sets of pins, the first is 16 pins and is used to connect the circuit to the sample columns, and the second consists of 16 pins and is also used to connect the circuit to the sample rows. The main function of the Adapter is to connect the test voltage from the microcontroller to the sample by directly contacting the pins of the Adapter with the sample. The microcontroller is connected to the Adapter via a 40-pin cable. The second mechanical platform this platform will be mobile and its location will be below the fixed platform that holds the Adapter, The function of this platform is to carry the sample to be tested, and this

platform is free to move in all directions Right - Left - Front - Back-top-bottom-and the movement of this platform can be controlled by knobs the first move the platform to the right and to the left, the second moves the platform forward and backward, and the third move the platform up and down. The purpose of the movement of the eye-holding platform from all directions is so that we can match the pins of the Adapter with the sample connections, columns, and rows 16X16 and so we can connect the test volt from the device to the sample by the 40-pin cable. The three processors will work together synchronously.The first processor and the second processor will count the pixels of the sample Matrix and the counting will start from Pixel number one to Pixel number 256. And Processor Number Three will turn on the liquid crystal display liquid crystal display LCD The function of this screen is to display the value of counting columns and rows during the testing process. The device is supplied with test voltages by means of power equipment the first equips the device with a continuous voltage of 15 V for the sample rows and the second equips the device with a continuous voltage of 20 V for the sample columns, these voltages enter the sample through the Adapter passing through the relays in the device these Relays are controlled by the processors for columns and rows.IDE Ribbon 40 Pin This tape connects the motherboard of the device to the adapter, allowing the transfer of voltages between external sources and the sample. The work of testing the sample pixels can be seen by adding a camera below the sample-carrying platform. This paper also discusses two proposals to improve the accuracy of the sample Tester، The first proposal is to design an interface on a computer screen using the LABVIEW program from the National Instrument Company, This interface is in the form of a matrix of LED light-Emitting Diodes 16X16. The outputs of the device being designed are then connected to the LEDs interface by DAQ 6008-6009, Or by Arduino Mega 2560. Both the 6008/6009 DAQ and the Arduino 2560 have entry and exit ports. we select the Analog entry ports. The second proposal is to manufacture a sample from a matrix of optical transistors placed under the sample to be tested identically, while the test device is working after the pixels, the sample to be tested will send a signal to the sample of optical transistors, this sample sends the data of this pixel to the computer by DAQ or Arduino. And finally, the outer cover of the device is made of transparent acrylic. Provides protection for internal components while allowing visibility for monitoring and analysis purposes.

The conclusion of the paper is that the device designed and implemented for testing TFT samples used in X-ray machines is able to automate the testing process and work autonomously. The device is powered by lithium-ion batteries and includes various electronic elements and components. The mechanical part of a used microscope is used in the device, along with a fixed platform and a moving platform for holding and testing the sample. Three microprocessors work together to count the pixels of the sample matrix and display the counting columns and rows on an LCD screen. The device is supplied with test voltages through relays controlled by the processors. The paper also discusses proposals to improve the accuracy of the sample tester, including designing an interface on a computer screen and using a matrix of optical transistors.

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RESUME

Ali Yaseen Ahmed AL RUBAYE completed his primary, meddle and secondary studies in Iraq Diyala Baquba, then joined the Technical Trainers Institute - Baghdad as a student in the electronics department, and then completed Medical Devices Engineering at the College of Electrical and Electronic Engineering Techniques in Baghdad as well and graduated in 2011. In the year 2021, began his postgraduate studies at the University of Karabuk as a master's student in the Department of Biomedical Engineering.

Accomplishments

- Design & implementation of smart suction unit, 2010.

- Design & implementation of smart Nebulaizer used Microcontroller 2011.

- Design & implementation of calibration mass air flow sensor for Opel & BMW cars 2011.

- Design & implementation of robotic hand ...upper Limbs 2012-2013.

- Design & implementation of robotic ... lower Limbs 2014-2015.

- Design & implementation of Glass Windows smart car 2015.

- Design & implementation of Smart Glasses 2016.

- Design & implementation of BVMD Blood viscosity Measurement Device PCV & HB reader 2017.

- Add a camera to the microscope and display the data on the computer screen 2017.

- Design and implementation of a student education system Explain the ECM function of modern vehicles 2017.

- Designing and implementing a training system for automotive engineering and diploma students, which is an advanced system 2018.

- Design and implementation of an educational device that shows the computer's audio errors and explains the locations of the motherboards of the computer using artificial intelligence 2018.

- Design & implementation of Smart fuel gateway for the Volkswagen hybrid cars 2017.

- Development of the (Quadcopter drone Phantom4) with the addition of two batteries to increase the flight period in 2018.

- Design and implementation of a file test device used in dental root drilling for a master's thesis in dentistry 2021.

- Design and implementation of a control device for motors at a distance of one kilometer using a computer interface and reading the RPM. Master's thesis2020.

- Design and implementation of a boxing simulator using a computer interface, a master's thesis 2019.

- Design and implementation of a rehabilitation device for athletes who suffer shoulder dislocation, Ph.D. thesis 2021.

- Design and implementation of a TFT LCD sample test device used in x-ray machines, my master's thesis 2023.