DESIGN AND FABRICATION OF MICROCONTROLLER BASED PICK AND PLACE ROBOT

A PROJECT REPORT

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During the above period, they were sincere, industrious and evinced keen interest in their Project work.

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ABSTRACT

In this project we design a job handling robot for pick and place applications. This project is aimed for the Industries for pick and place application, mainly for precious material handling application. The developed robot in this project will be used to retrieve the monolithic bricks from the conveyer.

In brick manufacturing industries the brick powder is compressed under high pressure to form monolithic bricks in the furnace. These bricks are placed on conveyor and moved using conveyor belt. The pick and place robot picks these bricks and arranges it in storage area. This project is designed with microcontroller, driver circuit along with motor, robot with pick & place model and key pad. In this project key pad consists of set of keys which specify the operation such as arm up and down, pick and place, 360 degree rotation. The key pad is interfaced to microcontroller through I/O port. Here the microcontroller is the flash type reprogrammable microcontroller in which we have already programmed.

With keypad, the microcontroller activates the driver circuit as per mentioned in the program. The driver circuit is constructed with transistor which acts as switch to control the relay. The relay output is directly connected to motor which is attached in the robot. The signal from the key is given to microcontroller. So the microcontroller activates the corresponding relay thorough the driver circuit. Now the arm moves to down side. Through this way arm is controlled for pick and place application.

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CHAPTER 1

INTRODUCTION

1.1.INTRODUCTION:

The term robot comes from the Czech word ***robota***, generally translated as "forced labor." This describes the majority of robots fairly well. Most robots in the world are designed for heavy, repetitive manufacturing work. They handle tasks that are difficult, dangerous or boring to human beings.

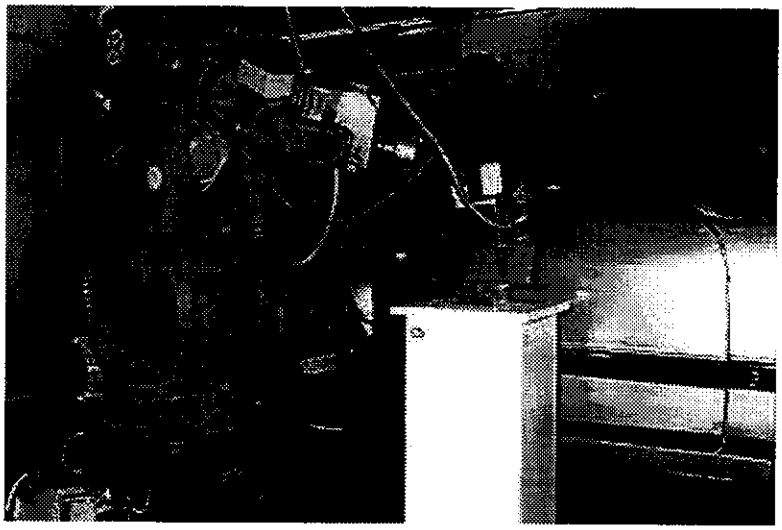


Fig.1.1.Robotic arm

The most common manufacturing robot is the **robotic arm**. A typical robotic arm is made up of seven metal segments, joined by six joints. The computer controls the robot by rotating individual **step motors** connected to each joint (some larger arms use hydraulics or pneumatics). Unlike ordinary motors, step motors move in exact increments (check out Anaheim Automation to find out how). This allows the computer to move the arm very precisely, repeating exactly the same movement over and over again. The robot uses motion sensors to make sure it moves just the right amount.

An industrial robot with six joints closely resembles a human arm -- it has the equivalent of a shoulder, an elbow and a wrist. Typically, the shoulder is mounted to a stationary base structure rather than to a movable body. This type of robot has six **degrees of freedom**, meaning it can pivot in six different ways. A human arm, by comparison, has seven degrees of freedom.

Your arm's job is to move your hand from place to place. Similarly, the robotic arm's job is to move an **end effector** from place to place. You can outfit robotic arms with all sorts of end effectors, which are suited to a particular application. One common end effector is a simplified version of the hand, which can grasp and carry different objects. Robotic hands often have built-in **pressure sensors** that tell the computer how hard the robot is gripping a particular object. This keeps the robot from dropping or breaking whatever it's carrying. Other end effectors include blowtorches, drills and spray painters.

Industrial robots are designed to do exactly the same thing, in a controlled environment, over and over again. For example, a robot might twist the caps onto peanut butter jars coming down an assembly line. To teach a robot how to do its job, the programmer guides the arm through the motions using a handheld controller. The robot stores the exact sequence of movements in its memory, and does it again and again every time a new unit comes down the assembly line.

Most industrial robots work in auto assembly lines, putting cars together. Robots can do a lot of this work more efficiently than human beings because they are so precise. They always drill in the exactly the same place, and they always tighten bolts with the same amount of force, no matter how many hours they've been working. Manufacturing robots are also very important in the computer industry. It takes an incredibly precise hand to put together a tiny microchip.

ROBOTIC ACTUATORS:

An actuator is a mechanism for activating process control equipment by use of pneumatic, hydraulic, or electronic signals. There are several types of actuators in robotic arms.

1)Synchronous - The motor contains a rotor that rotates in synchrony with the oscillating field or current.

- **Brushless DC Servo** - This synchronous electric motor features permanent magnet poles on the rotor, which are attracted to the rotating poles of the opposite magnetic polarity in the stator creating torque. It is powered by a DC current that has an electronically controlled commutation system instead of a system based on brushes. Current, torque, voltage, and rpm are linearly related. The advantages of a brushless motor include higher efficiency and reliability, reduced noise, longer lifetime (no brush erosion), elimination of ionizing sparks from the commutator, and an overall reduction of electromagnetic interference (EMI).

- **Stepper** - A type of brushless servo motor, this motor is generally electric and moves or rotates in small discrete steps. Stepper motors offer many advantages, such as dual compatibility with both analog and digital feedback signals. They can be used to easily accelerate a load because the maximum dynamic torque occurs at low pulse rates. Drawbacks of their use include low efficiency; much of the input energy is dissipated as heat and the inputs must be matched to the motor and load. The load should be carefully analyzed for optimal performance. Damping may be required when load inertia is exceptionally high to prevent oscillation.
- **Brushed DC Servo** - The classic DC motor generates an oscillating current in a rotor with a split ring commutator, and either a wound or permanent magnet stator. A coil is wound around the rotor, which is then powered by a battery. The rotational speed is proportional to the voltage applied to it and the torque is proportional to the current. Speed control can be achieved by applying tape to the battery, varying the supply voltage, resistors, or electronic controls. The advantage to using a brushed motor over a brushless is cost. The brushless motor requires more complex electronic speed controls; however a brushed DC motor can be regulated by a simple variable resistor, such as a potentiometer or rheostat. This is not efficient, but proves satisfactory for cost-sensitive applications.

2)Asynchronous - This motor is designed to slip in order to generate torque.

- **Traction Motor** - A type of electric motor that is used to power the driving wheels of a vehicle. The availability of high-powered semiconductors has now made practical the use of much simpler, higher-reliability AC induction motors known as asynchronous traction motors.

- **AC Servo Motors** - Used in applications that require a rapid and accurate response, these motors are basically two-phase, reversible induction motors that are modified for servo operation. AC Servo motors have a small diameter and high resistance rotors. This design provides low inertia for fast starts, stops, and reversals. AC Servo Motors can also be classified as asynchronous or synchronous.
- **Pneumatic** - Powered by the conversion of compressed air, these actuators are used to control processes that require a quick and accurate response, but not a large amount of force. These compact and lightweight actuators are less energy efficient than electric motors.
- **Hydraulic** - With the ability to convert hydraulic pressure and flow into torque and rotation, these actuators can be used when a large amount of force is needed. The most common example is a piston. This motor uses hydraulic fluid under pressure to drive machinery. The energy comes from the flow and pressure, not the kinetic energy of the flow.

ROBOT MECHANISMS AND KINEMATICS:

Robot Manipulator Styles

- Articulated (Jointed-Arm) - This rotary jointed body can range from simple two-jointed structures to systems with ten or more interacting joints. The advantage of articulated robot arms is that the configuration enables the robot to reach any part in the working envelope.
- SCARA
- Cartesian
- Cylindrical
- Polar

1.2. OBJECTIVE:

The objective of this project is to design a Robot arm, controlled by a microcontroller to pick the monolithic bricks moving on a conveyor belt.

1.3. EXISTING SYSTEM AND NEEDS:

In brick manufacturing industries the brick powder is compressed under high pressure to form monolithic bricks in the furnace. These bricks are placed on conveyor and moved for a short distance using conveyor belt. The process is semi automatic. After the brick moves a certain distance the conveyor belt is stopped till next brick is placed in it. At the end of the conveyor belt the brick has to be transferred to the required store area manually. But the temperature of the brick is very high and each monolithic brick weighs around 50kg. Hence, the brick is allowed to cool for a certain period and then it is transferred to the destined place by more than one worker after taking proper precautions. The conveyor belt is then switched on and it returns to collect the next set of bricks.

DRAWBACKS OF THE MANUAL SYSTEM:

- Workers have to wait till the bricks cool down.
- Two workers are required to lift the brick as the weight will be very high.
- Time consuming as all the works are done manually.
- Not safe as manual errors like dropping may occur.
- The process may be delayed due to labour problems.

PICK AND PLACE ROBOT:

To overcome these disadvantages pick and place robots are designed. The important features of this is:

- The robot is capable of handling hot bricks.
- One person is enough to operate.
- High speed of action.
- Safety to worker is high.
- Highly accuracy.

ADVANTAGE OF PICK AND PLACE ROBOTS:

- **Speed** - Pick and place robots allow for faster cycle times.
- **Accuracy** - Robotic systems are more accurate and consistent than their human counterparts.
- **Production** - Work cells create more because they perform applications with more accuracy, speed and tirelessness. The consistent output of a robotic system along with quality and repeatability are unmatched
- **Reliability** - Robots can work 24 hours a day, seven days a week without stopping or tiring.
- **Flexibility** - Pick and place robots can be reprogrammable and tooling can be interchanged to provide for multiple applications.
- **Savings** - Managers are realizing the long term savings with a pick and place robotic workcell rather than the operation they are currently doing. An increase in output with a material handling robotic system has saved factories money.
- **Affordability** - With the advancements in technology, and robotics becoming more affordable pick and place robotic cells are being installed for many different pick and place automation applications.

1.4. OUTLINE OF THESIS:

Chapter 1: Introduction to the project describing about the robotic arm, objective of the project, drawbacks of existing system and the advantages of pick and place robot.

Chapter 2: Describes the overall system.

Chapter 3: Pick and Place robot components- Gives brief description about power supply used in the system, DC motor control, stepper motor and Keypad of the system.

Chapter 4: Method and control-Describes the operation of pick and place robot and about the Microcontroller (AT89C51) used in this system. The algorithm and flow chart of the design is also described.

Chapter 5: PCB designing process-Details about PCB drawing and fabrication.

Chapter 6: Conclusion – The project done and the scope for future work are discussed.

Appendices: Gives the features and the specification of the ICs. Program and circuit diagram of this project are also included.

CHAPTER 2

OVERALL SYSTEM

2.1. INTRODUCTION:

The overall system of Pick and Place Robot mechanism consists of a Keypad interfaced to microcontroller. The microcontroller is connected to the stepper motor and DC motor by means of driver circuit as shown in fig 2.1. The driver circuit drives the motors on the basis of the command given by the microcontroller.

There is a stepper motor placed on the base which facilitates the rotation of the base i.e. the movement of robot in clockwise and anticlockwise direction. There are three DC motors placed on arm, elbow and wrist respectively. The motor in the arm performs the movement in up and down direction. The motor in elbow performs the movement up and down at oblique angle. The motor in the wrist acts as gripper and it facilitates the open and close function. Thus these three motors together perform the Pick and Place function.

2.1. OVERALL BLOCK DIAGRAM:

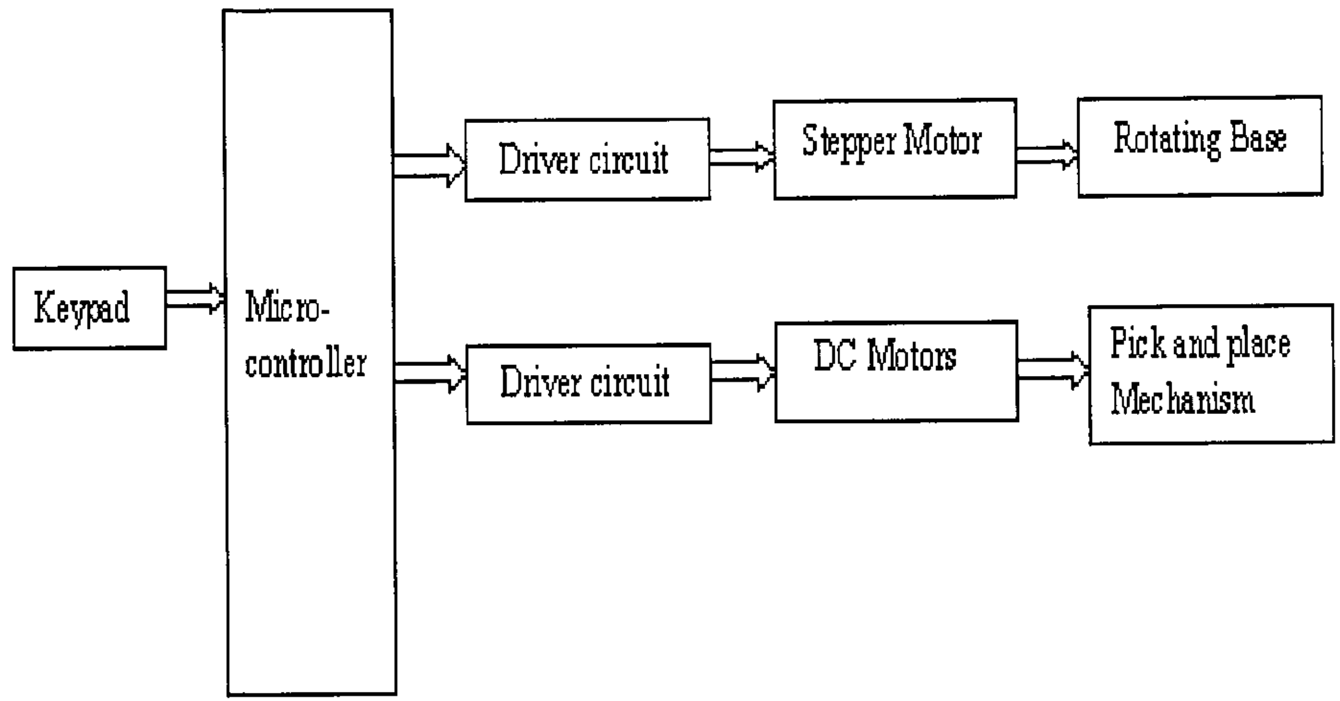


Fig 2.1. Overall Block Diagram

2.3. DESCRIPTION:

The pick and place robot consists of a keypad interfaced with a microcontroller which in turn is connected to stepper driver circuit and DC motor driver circuit. The stepper motor driver circuit is connected to the stepper motor which performs the function of rotating base. The DC driver circuit is connected to three DC motors which performs the pick and place mechanism.

The microcontroller is connected to 2^{nd}, 10^{th}, 12^{th} and 14^{th} pin of the booster present in the stepper driver card. When right key is pressed in keypad, the microcontroller gives forward pulses(5, 9, A, 6) to the stepper driver which energises the winding in the stepper motor alternately and hence the stepper motor moves in right side at a preset step angle.

Similarly when left key is pressed in keypad, the microcontroller gives reverse pulses (6, A, 9, 5) to the stepper motor and hence it moves in opposite direction i.e. left side.

The DC motors perform the following movement: Rotational arm movement, Vertical arm movement and Rotational wrist movement.

When up key is pressed in keypad, signal from microcontroller goes to DC motor driver circuit. This circuit is designed to control the motor in the forward and reverse direction. The DC motor1 will move the arm moves in vertical movement rod up till the set limit.

Similarly when down key is pressed, The DC motor 1 will move the arm in the vertical movement rod down till the set limit.

When the elbow up key is pressed in the keypad, the DC motor2 will move up the forearm up at an angle till the set limit. Similarly, when elbow down key is pressed in the keypad, the DC motor2 will move down the forearm at an angle down till the set limit.

When the open key is pressed in the keypad, the DC motor3 will open the gripper till the set limit. Similarly, when close key is pressed in the keypad, the DC motor3 will close the gripper till the set limit.

CHAPTER 3

PICK AND PLACE ROBOT COMPONENTS

3.1. POWER SUPPLY:

3.1.1. INTRODUCTION:

Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remains the same even if the input dc voltage varies, or the output load connected to the dc voltage changes.

A block diagram containing the parts of a typical power supply and the voltage at various points in the unit is shown in fig 3.1. The ac voltage, typically 120 V rms, is connected to a transformer, which steps that ac voltage down to the level for the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage varies somewhat, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of a number of popular voltage regulator IC units.

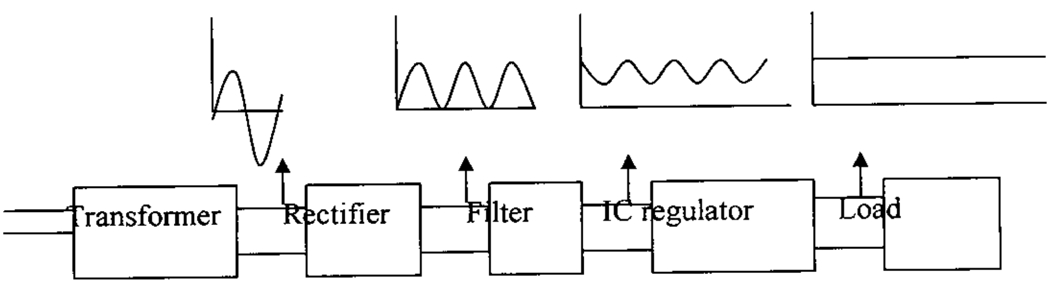


Fig 3.1. Block diagram of Power supply

3.1.2. WORKING PRINCIPLE:

Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 vOlts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

IC voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD --------- 5 volts
- For alarm circuit, op-amp, relay circuits ---------- 12 volts

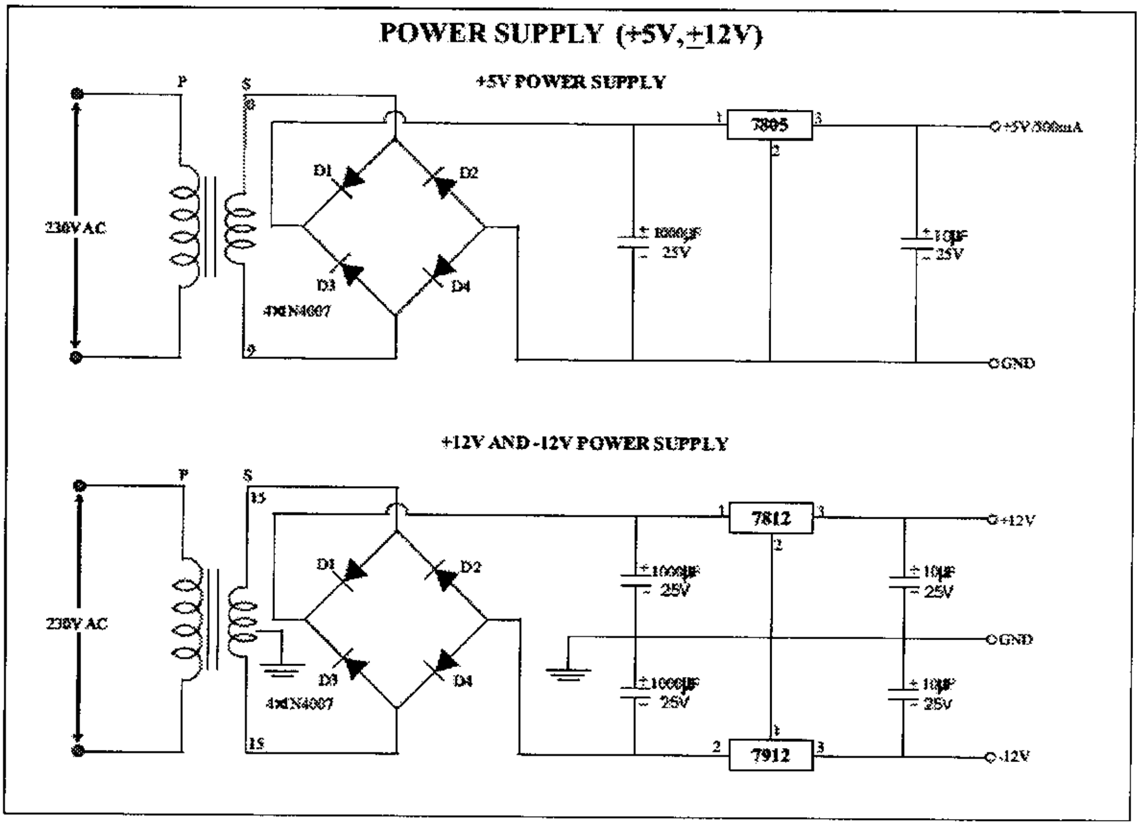


Fig 3.2. Circuit Diagram of power supply

3.1.3. THREE-TERMINAL VOLTAGE REGULATORS:

Fig shows the basic connection of a three-terminal voltage regulator IC to a load. The fixed voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated output dc voltage, Vo, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

Fixed Positive Voltage Regulators:

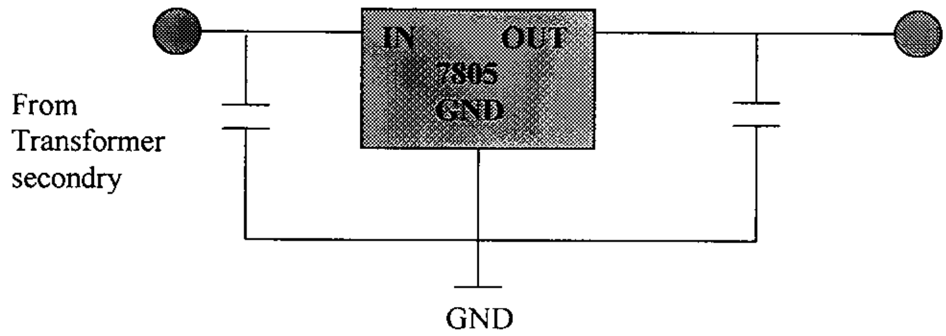


Fig.3.3. Fixed Positive Voltage Regulator

The series 78 regulators provide fixed regulated voltages from 5 to 24 V. Figure 19.26 shows how one such IC, a 7812, is connected to provide voltage regulation with output from this unit of +12V dc. An unregulated input voltage Vi is filtered by capacitor C1 and connected to the IC's IN terminal. The IC's OUT terminal provides a regulated + 12V which is filtered by capacitor C2 (mostly for any high-frequency noise). The third IC terminal is connected to ground (GND). While the input voltage may vary over some permissible voltage range, and the output load may vary over some acceptable range, the output voltage remains constant within specified voltage variation limits. These limitations are spelled out in the manufacturer's specification sheets.

3.2. DC MOTOR FORWARD AND REVERSE CONTROL:

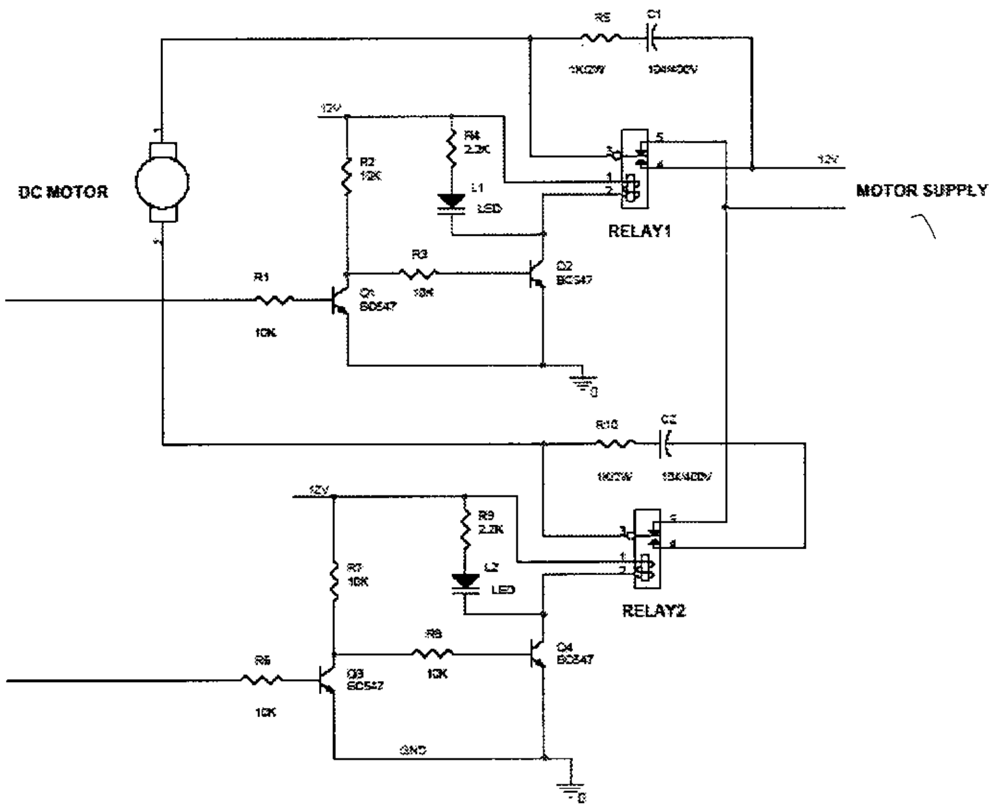


Fig.3.4. DC Motor Forward and Reverse Control

This circuit is designed to control the motor in the forward and reverse direction. It consists of two relays named as relay1, relay2. The relay ON and OFF is controlled by the pair of switching transistors. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO). The common pin of two relay is connected to positive and negative terminal of motor through snubber circuit respectively. The relays are connected in the collector terminal of the transistors T2 and T4.

When high pulse signal is given to either base of the T1 or T3 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the T2 or T4 transistor. So the relay is turned OFF state.

When low pulse is given to either base of transistor T1 or T3 transistor, the transistor is turned OFF. Now 12v is given to base of T2 or T4 transistor so the transistor is conducting and relay is turn ON. The NO and NC pins of two relays are interconnected so only one relay can be operated at a time.

The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back emf may fault the relays. So the back emf is grounded through the snubber circuit.

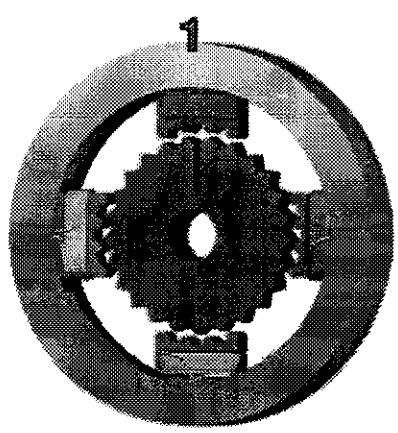
- When relay 1 is in the ON state and relay 2 is in the OFF state, the motor is running in the forward direction.
- When relay 2 is in the ON state and relay 1 is in the OFF state, the motor is running in the reverse direction.

3.3. STEPPER MOTOR:

A **stepper motor** is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps, for example, 200 steps. Thus the motor can be turned to a precise angle.

3.3.1. FUNDEMENTALS OF OPERATION:

Stepper motors operate much differently from normal DC motors, which simply spin when voltage is applied to their terminals. Stepper motors, on the other hand, effectively have multiple "toothed" electromagnets arranged around a central metal gear, as shown at right. To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one, and from there the process is repeated. Each of those slight rotations is called a "step." In that way, the motor can be turned a precise angle. There are two basic arrangements for the electromagnetic coils: bipolar and unipolar.



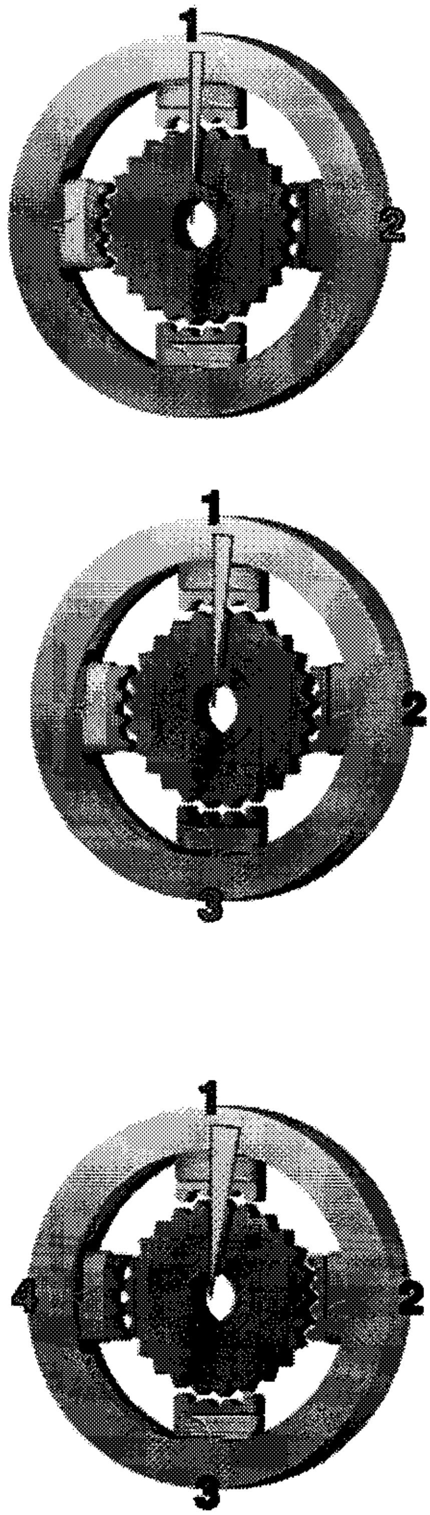


Fig.3.5. Modes of Operation

A step motor can be viewed as a DC motor with the number of poles (on both rotor and stator) increased, taking care that they have no common denominator. Additionally, soft magnetic material with many teeth on the rotor and stator cheaply multiplies the number of poles (reluctance motor). Like an AC synchronous motor, it is ideally driven by sinusoidal current, allowing a stepless operation, but this puts some burden on the controller. When using an 8-bit digital controller, 256 microsteps per step are possible. As a digital-to-analog converter produces unwanted ohmic heat in the controller, pulse-width modulation is used instead to regulate the mean current. Simpler models switch voltage only for doing a step, thus needing an extra current limiter: for every step, they switch a single cable to the motor. Bipolar controllers can switch between supply voltage, ground, and unconnected. Unipolar controllers can only connect or disconnect a cable, because the voltage is already hard wired. Unipolar controllers need center-tapped windings.

It is possible to drive unipolar stepper motors with bipolar drivers. The idea is to connect the output pins of the driver to 4 transistors. The transistor must be grounded at the emitter and the driver pin must be connected to the base. Collector is connected to the coil wire of the motor.

Stepper motors are rated by the torque they produce. Synchronous electric motors using soft magnetic materials (having a core) have the ability to provide position holding torque (called *detent torque*, and sometimes included in the specifications) while not driven electrically. To achieve full rated torque, the coils in a stepper motor must reach their full rated current during each step. The voltage rating (if there is one) is almost meaningless. The motors also suffer from EMF, which means that once the coil is turned off it starts to generate current because the motor is still rotating. There needs to be an explicit way to handle this extra current in a circuit otherwise it can cause damage and affect performance of the motor.

The stepper motor is having four windings named as A, B, C, D, which are energized by the separate driver circuit. The driver circuit consists of transistor network BC547 and 3055, flywheel diode and current booster 7047

The stepper motor windings are energized sequentially which is controlled by the microcontroller. If the microcontroller sends the binary data in the order of 5, 9, A, and 6 the stepper motor is rotating in the forward direction. If the microcontroller sends the binary data in the order of 6, A, 9, and 5 the stepper motor is rotating in the reverse direction

3.3.2. CIRCUIT WORKING DESCRIPTION:

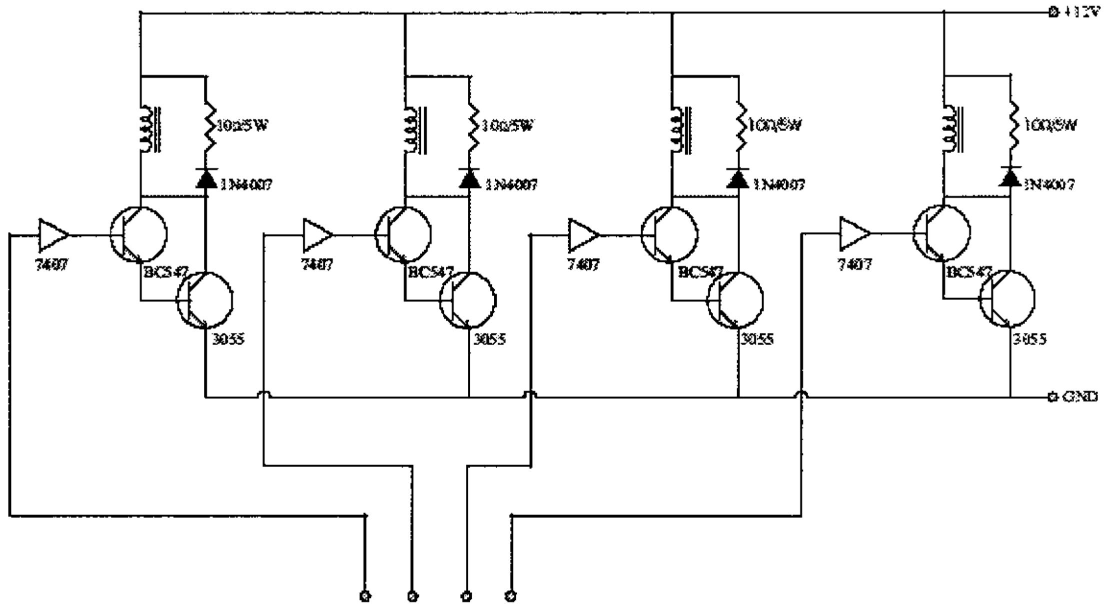


Fig 3.6. Stepper Driver Card

For an example if the binary data 5 (0101) given to driver circuit, the winding A and C are energized through transistor networks. The 7047 is used to boost the current signal. If windings are energized and de-energized continuously it generating the back EMF it may damage the windings. The flywheel diode is used to avoid the damage from the back EMF.

3.4. KEYPAD:

A numeric keypad, or numpad for short, is the small, palm-sized, seventeen key section of a computer keyboard, usually on the very far right. The numeric keypad features digits 0 to 9, addition (+), subtraction (-), multiplication (*) and division (/) symbols, a decimal point (.) and Num Lock and Enter keys. Laptop keyboards often do not have a numpad, but may provide numpad input by holding a modifier key (typically lapelled "Fn") and operating keys on the standard keyboard. Particularly large laptops (typically those with a 17 inch screen or larger) may have space for a real numpad, and many companies sell separate numpads which connect to the host laptop by a USB connection.

Numeric keypads usually operate in two modes: when Num Lock is off, keys 8, 6, 2, 4 act like an arrow keys and 7, 9, 3, 1 act like Home, PgUp, PgDn and End; when Num Lock is on, digits keys produce corresponding digits. These, however, differ from the numeric keys at the top of the keyboard in that, when combined with the Alt key on a PC, they are used to enter characters which may not be otherwise available: for example, Alt-0169 produces the copyright symbol. These are referred to as Alt codes.

On Apple Computer Macintosh computers, which lack a Num Lock key, the numeric keypad always produces only numbers. The num lock key is replaced by the clear key.

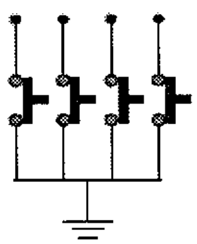


Fig.3.7. Numeric keypad

Numeric keypads usually operate in two modes: when Num Lock is off, keys 8, 6, 2, 4 act like an arrow keys and 7, 9, 3, 1 act like Home, PgUp, PgDn and End; when Num Lock is on, digits keys produce corresponding digits. These, however, differ from the numeric keys at the top of the keyboard in that, when combined with the Alt key on a PC, they are used to enter characters which may not be otherwise available: for example, Alt-0169 produces the copyright symbol. These are referred to as Alt codes.

CHAPTER 4

METHOD AND CONTROL

4.1. WORKING OF PICK AND PLACE ROBOT:

The pick and place robot consist of

- A hollow base cuboid for housing the stepper motor (25cm*25cm*10cm).
- A cylindrical vertical movement rod (40cm height*3cm diameter).
- A vertical support.
- Arm (20cm).
- Forearm (20cm).
- Gripper (12cm).
- Three DC motors.
- One Stepper motor.
- Keypad as shown in the figure below.

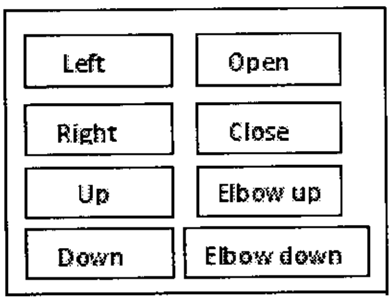


Fig. 4.1. Keypad

Operation:

The pick and place robot consists of a keypad interfaced with a microcontroller which in turn is connected to stepper driver circuit and DC motor driver circuit. The stepper motor driver circuit is connected to the stepper motor which performs the function of rotating base. The DC driver circuit is connected to three DC motors which performs the pick and place mechanism.

The microcontroller is connected to 2^{nd}, 10^{th}, 12^{th} and 14^{th} pin of the booster present in the stepper driver card. When right key is pressed in keypad, the microcontroller gives forward pulses(5, 9, A, 6) to the stepper driver.

When the stepper driver receives the pulse 5 i.e. 0101 the current flows through 10^{th} and 14^{th} pin of booster which boosts the signal and gives it to darlington amplifier. The darlington pair amplifies the current and energies the 2^{nd} and 4rth winding.

Next the stepper driver receives the pulse 9 i.e.1001. Now the current flows through 2nd and 14th pin of booster and sent to darlington pair for amplification. This energises the 1st and 4th winding. Thus the stepper motor moves through an angle of 2 degree.

Next the stepper driver receives the pulse A i.e.1010. Now the current flows through 2nd and 12th pin of booster and sent to darlington pair for amplification. This energises the 1st and 3rd winding. Thus the stepper motor moves through an angle of 2 degree.

Next the stepper driver receives the pulse 6 i.e.0110. Now the current flows through 10th and 12th pin of booster and sent to darlington pair for amplification. This energises the 2nd and 3rd winding. Thus the stepper motor moves through an angle of 2 degree. Thus the stepper motor moves in right side.

Similarly when left key is pressed in keypad, the microcontroller gives reverse pulses (6, A, 9, 5) to the stepper motor and hence it moves in opposite direction i.e. left side.

The DC motors perform the following movement:

Rotational arm movement

Vertical arm movement

Rotational wrist movement

When up key is pressed in keypad, signal from microcontroller goes to DC motor driver circuit. This circuit is designed to control the motor in the forward and reverse direction. It consists of two relays named as relay1, relay2. The relay ON and OFF is controlled by the pair of switching transistors. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO). The common pin of two relay is connected to positive and negative terminal of motor through snubber circuit respectively. The relays are connected in the collector terminal of the transistors T2 and T4.

When high pulse signal is given to either base of the T1 or T3 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the T2 or T4 transistor. So the relay is turned OFF state.

When low pulse is given to either base of transistor T1 or T3 transistor, the transistor is turned OFF. Now 12v is given to base of T2 or T4 transistor so the transistor is conducting and relay is turn ON. The NO and NC pins of two relays are interconnected so only one relay can be operated at a time.

The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back emf may fault the relays. So the back emf is grounded through the snubber circuit.

- When relay 1 is in the ON state and relay 2 is in the OFF state, the motor is running in the forward direction.
- When relay 2 is in the ON state and relay 1 is in the OFF state, the motor is running in the reverse direction.

The DC motor1 will move the arm moves in vertical movement rod up till the set limit. Similarly when down key is pressed, The DC motor 1 will move the arm in the vertical movement rod down till the set limit.

When the elbow up key is pressed in the keypad, the DC motor2 will move up the forearm at an angle till the set limit. Similarly, when elbow down key is pressed in the keypad, the DC motor2 will move down the forearm at an angle till the set limit.

When the open key is pressed in the keypad, the DC motor3 will open the gripper till the set limit. Similarly, when close key is pressed in the keypad, the DC motor3 will close the gripper till the set limit.

4.2. MICROCONTROLLER:

4.2.1. INTRODUCTION TO ATMEL MICROCONTROLLER:

SERIES: 89C51 Family, TECHNOLOGY: CMOS

The major Features of 8-bit Micro controller ATMEL 89C51:

- 8 Bit CPU optimized for control applications
- Extensive Boolean processing (Single - bit Logic) Capabilities.
- On - Chip Flash Program Memory
- On - Chip Data RAM
- Bi-directional and Individually Addressable I/O Lines
- Multiple 16-Bit Timer/Counters
- Full Duplex UART
- Multiple Source / Vector / Priority Interrupt Structure
- On - Chip Oscillator and Clock circuitry.
- On - Chip EEPROM
- SPI Serial Bus Interface
- Watch Dog Timer

AT89CS1 is the 40 pins, 8 bit Microcontroller manufactured by Atmel group. It is the flash type reprogrammable memory. Advantage of this flash memory is we can erase the program with in few minutes. It has 4kb on chip ROM and 128 bytes internal RAM and 32 I/O pin as arranged as port 0 to port 3 each has 8 bit bin .

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51™ instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer.

4.2.2. MEMORY ORGANIZATION:

* Logical Separation of Program and Data Memory *

All Atmel Flash micro controllers have separate address spaces for porgram and data memory as shown in Fig 1.The logical separation of program and data memory allows the data memory to be accessed by 8 bit addresses . Which can be more quickly stored and manipulated by an 8 bit CPU Nevertheless 16 Bit data memory addresses can also be generated through the DPTR register.

Program memory can only be read. There can be up to 64K bytes of directly addressable program memory. The read strobe for external program memory is the Program Store Enable Signal (PSEN) Data memory occupies a separate address space from program memory. Up to 64K bytes of external memory can be directly addressed in the external data memory space. The CPU generates read and write signals, RD and WR, during external data memory accesses. External program memory and external data memory can be combined by an applying the RD and PSEN signals to the inputs of AND gate and using the output of the fate as the read strobe to the external program/data memory.

PROGRAM MEMORY:

The map of the lower part of the program memory, after reset, the CPU begins execution from location 0000h. Each interrupt is assigned a fixed location in program memory. The interrupt causes the CPU to jump to that location, where it executes the service routine. External Interrupt 0 for example, is assigned to location 0003h. If external Interrupt 0 is used, its service routine must begin at location 0003h. If the I interrupt in not used its service location is available as general-purpose program memory.

The interrupt service locations are spaced at 8 byte intervals 0003h for External interrupt 0, 000Bh for Timer 0, 0013h for External interrupt 1,001Bh for Timer1, and so on. If an Interrupt service routine is short enough (as is often the case in control applications) it can reside entirely within that 8-byte interval. Longer service routines can use a jump instruction to skip over subsequent interrupt locations. If other interrupts are in use. The lowest addresses of program memory can be either in the on-chip Flash or in an external memory. To make this selection, strap the External Access (EA) pin to either Vcc or GND. For example, in the AT89C51 with 4K bytes of on-chip Flash, if the EA pin is strapped to Vcc, program fetches to addresses 0000h through 0FFFh are directed to internal Flash. Program fetches to addresses 1000h through FFFFh are directed to external memory.

DATA MEMORY:

The Internal Data memory is dived into three blocks namely, Refer Fig

- The lower 128 Bytes of Internal RAM.
- The Upper 128 Bytes of Internal RAM.
- Special Function Register

Internal Data memory Addresses are always 1 byte wide, which implies an address space of only 256 bytes. However, the addressing modes for internal RAM can in fact accommodate 384 bytes. Direct addresses higher than 7Fh access one memory space, and indirect addresses higher than 7Fh access a different Memory Space.

The lowest 32 bytes are grouped into 4 banks of 8 registers. Program instructions call out these registers as R0 through R7. Two bits in the Program Status Word (PSW) Select, which register bank, is in use. This architecture allows more efficient use of code space, since register instructions are shorter than instructions that use direct addressing.

The next 16-bytes above the register banks form a block of bit addressable memory space. The micro controller instruction set includes a wide selection of single - bit instructions and this instruction can directly address the 128 bytes in this area. These bit addresses are 00h through 7Fh. either direct or indirect addressing can access all of the bytes in lower 128 bytes. Indirect addressing can only access the upper 128. The upper 128 bytes of RAM are only in the devices with 256 bytes of RAM.

The Special Function Register includes Ports latches, timers, peripheral controls etc., direct addressing can only access these register. In general, all Atmel micro controllers have the same SFRs at the same addresses in SFR space as the AT89C51 and other compatible micro controllers. However, upgrades to the AT89C51 have additional SFRs. Sixteen addresses in SFR space are both byte and bit Addressable. The bit Addressable SFRs are those whose address ends in 000B. The bit addresses in this area are 80h through FFh.

4.2.3. PIN DIAGRAM:

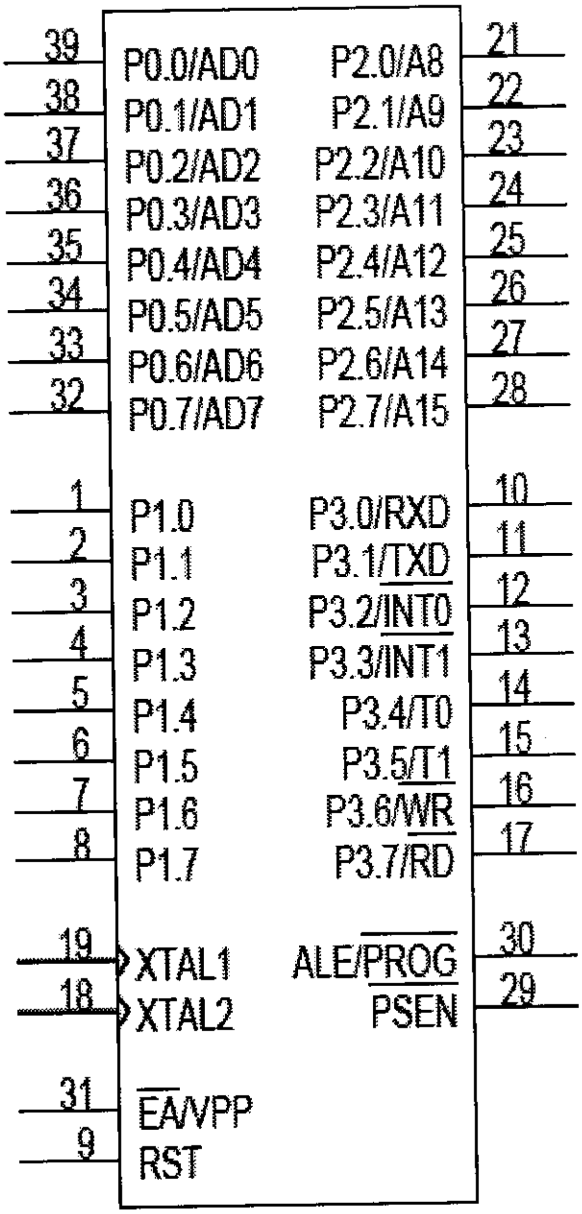


Fig 4.2. Pin diagram of AT89C51

4.2.4. PIN DESCRIPTION:

VCC

Supply voltage.

GND

Ground.

Port 0

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 may also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode P0 has internal pullups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pullups are required during program verification.

Port 1

Port 1 is an 8-bit bidirectional I/O port with internal pullups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pullups. Port 1 also receives the low-order address bytes during Flash programming and verification.

Port 2

Port 2 is an 8-bit bidirectional I/O port with internal pullups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application it uses strong internal pull-ups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bidirectional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups. Port 3 also serves the functions of various special features of the AT89C51 as listed below:

Table 4.1. Functions of Port 3 (AT89C51)

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{INT0}$ (external interrupt 0)
P3.3	$\overline{INT1}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{WR}$ (external data memory write strobe)
P3.7	$\overline{RD}$ (external data memory read strobe)

Port 3 also receives some control signals for Flash programming and verification.

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/PROG

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation ALE is emitted at a constant rate of 1/6 the oscillator frequency, and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external Data Memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require 12-volt VPP.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

Oscillator Characteristics

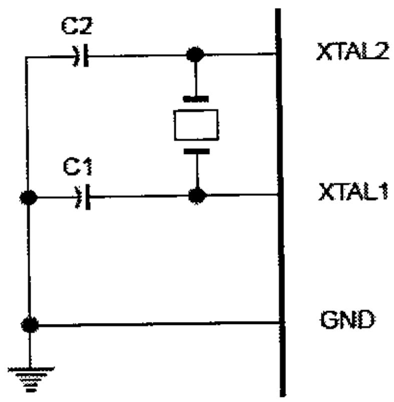
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 5.3. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 5.4. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

Idle Mode

In idle mode, the CPU puts itself to sleep while all the onchip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset. It should be noted that when idle is terminated by a hard ware reset, the device normally resumes program execution, from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when Idle is terminated by reset, the instruction following the one that invokes Idle should not be one that writes to a port pin or to external memory.

Table 4.2. Status of External Pins during Idle and Power Down Modes

Mode	Program Memory	ALE	$\overline{PSEN}$	PORT0	PORT1	PORT2	PORT3
Idle	Internal	1	1	Data	Data	Data	Data
Idle	External	1	1	Float	Data	Address	Data
Power Down	Internal	0	0	Data	Data	Data	Data
Power Down	External	0	0	Float	Data	Data	Data



Note: C1, C2 = 30 pF ± 10 pF for Crystals
= 40 pF ± 10 pF for Ceramic Resonators

Fig 4.3. Oscillator Connections

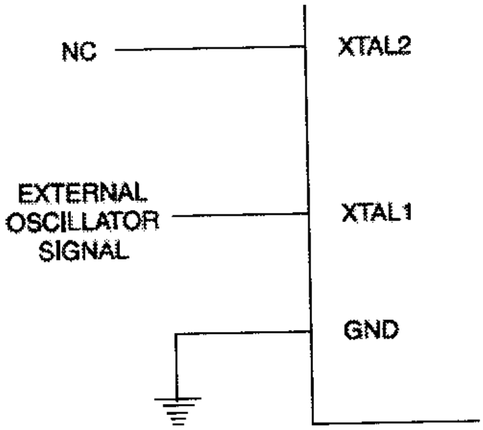


Fig 4.4. External Clock Drive Configuration

4.2.5. PROGRAMMING THE ON-CHIP FLASH MEMORY:

The AT89C51 is normally shipped with the on-chip Flash memory array in the erased state (that is, contents = FFH) and ready to be programmed. The programming interface accepts either a high-voltage (12-volt) or a low-voltage (VCC) program enable signal. The low voltage programming mode provides a convenient way to program the AT89C51 inside the user's system, while the high-voltage programming mode is compatible with conventional third party Flash or EPROM programmers. The AT89C51 is shipped with either the high-voltage or low-voltage programming mode enabled. The respective top-side marking and device signature codes are listed in the following table.

Table 4.3. Top-side marking and signature codes

	V_{PP} = 12V	V_{PP} = 5V
Top-Side Mark	AT89C51 xxxx yyww	AT89C51 xxxx-5 yyww
Signature	(030H)=1EH (031H)=51H (032H)=FFH	(030H)=1EH (031H)=51H (032H)=05H

The AT89C51 code memory array is programmed byte-by-byte in either programming mode. To program any nonblank byte in the on-chip Flash Memory, the entire memory must be erased using the Chip Erase Mode.

Programming Algorithm: Before programming the AT89C51, the address, data and control signals should be set up according to the Flash programming mode table and Figures 3 and 4.

To program the AT89C51, take the following steps.

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise EA/VPP to 12V for the high-voltage programming mode.
5. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

Data Polling: The AT89C51 features Data Polling to indicate the end of a write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written datum on PO.7. Once the write cycle has been completed, true data are valid on all outputs, and the next cycle may begin. Data Polling may begin any time after a write cycle has been initiated.

Ready/Busy: The progress of byte programming can also be monitored by the RDY/BSY output signal. P3.4 is pulled low after ALE goes high during programming to indicate BUSY. P3.4 is pulled high again when programming is done to indicate READY.

Program Verify: If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. The lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

Chip Erase: The entire Flash array is erased electrically by using the proper combination of control signals and by holding ALE/PROG low for 10 ms. The code array is written with all "1"s. The chip erase operation must be executed before the code memory can be re-programmed.

Reading the Signature Bytes: The signature bytes are read by the same procedure as a normal verification of locations 030H, 031H, and 032H, except that P3.6 and P3.7 must be pulled

to a logic low. The values returned are as follows.

(030H) = 1EH indicates manufactured by Atmel

(031H) = 51H indicates 89C51

(032H) = FFH indicates 12V programming

(032H) = 05H indicates 5V programming

Table 4.4.Flash Programming Modes

Mode		RST	$\overline{PSEN}$	ALE/$\overline{PROG}$	$\overline{EA}$/Vpp	P2.6	P2.7	P3.6	P3.7
Write Code Data		H	L		H/12V	L	H	H	H
Read Code Data		H	L	H	H	L	L	H	H
Write Lock	Bit - 1	H	L		H/12V	H	H	H	H
	Bit - 2	H	L		H/12V	H	H	L	L
	Bit - 3	H	L		H/12V	H	L	H	L
Chip Erase		H	L	(1)	H/12V	H	L	L	L
Read Signature Byte		H	L	H	H	L	L	L	L

Note: 1. Chip Erase requires a 10-ms PROG pulse.

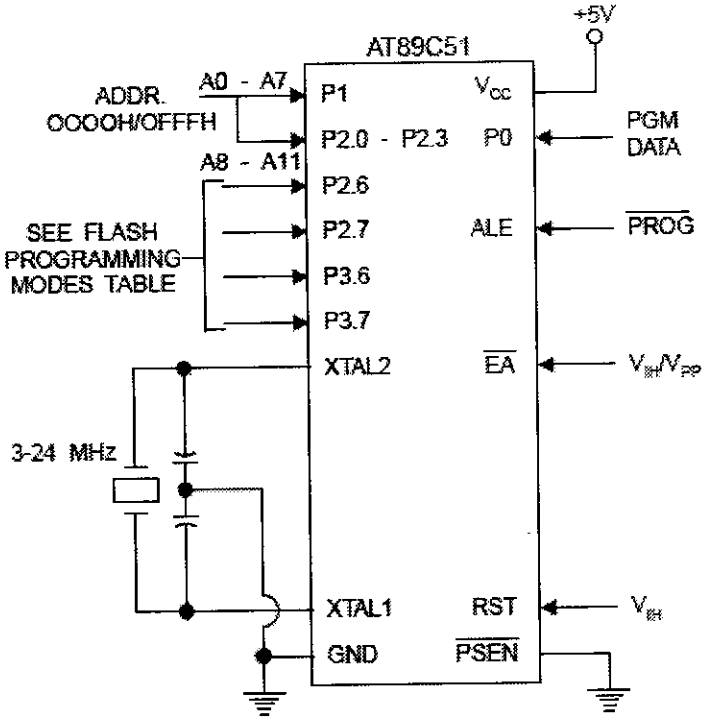


Fig 4.5. Programming the Flash

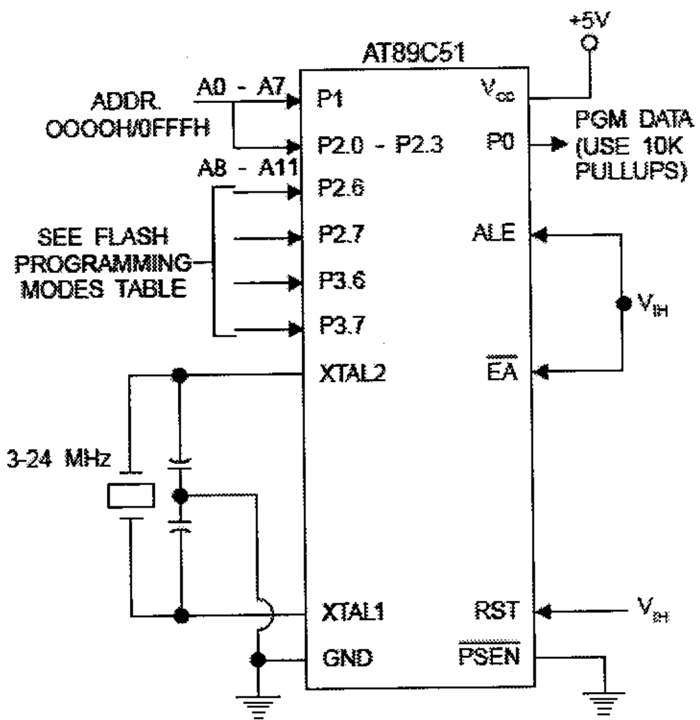


Fig.4.6. Verifying the flash

4.3. ALGORITHM:

Step 1: Declare all port pins, initialize all variable=1.

Step 2: If right key is pressed and backward limit switch is not tripped, then goto step 3 else goto step 4.

Step 3: Forward pulses are given to stepper motor and the arm moves right.

Step 4: If left key is pressed and reverse limit switch is not tripped, then goto step 5 else goto Step 6.

Step 5: Reverse pulses are given to stepper motor and the arm moves left.

Step 6: If up key is pressed and up limit switch is not tripped , then goto step 7 else goto step 8.

Step 7: The arm moves up until set limit.

Step 8: If down key is pressed and down limit switch is not tripped, then goto step 9 else goto Step 10.

Step 9: The arm moves down until set limit.

Step 10: If elbow up key is pressed and up limit switch is not tripped, then goto step 11 else Goto step 12.

Step 11: The elbow moves up until set limit.

Step 12: If elbow down key is pressed and down limit switch is not tripped, then goto step 13 Else goto step 14.

Step 13: The elbow moves down until set limit.

Step 14: If close key is pressed and close limit switch is not tripped, then goto step 15 else goto Step 16.

Step 15: Close the hand.

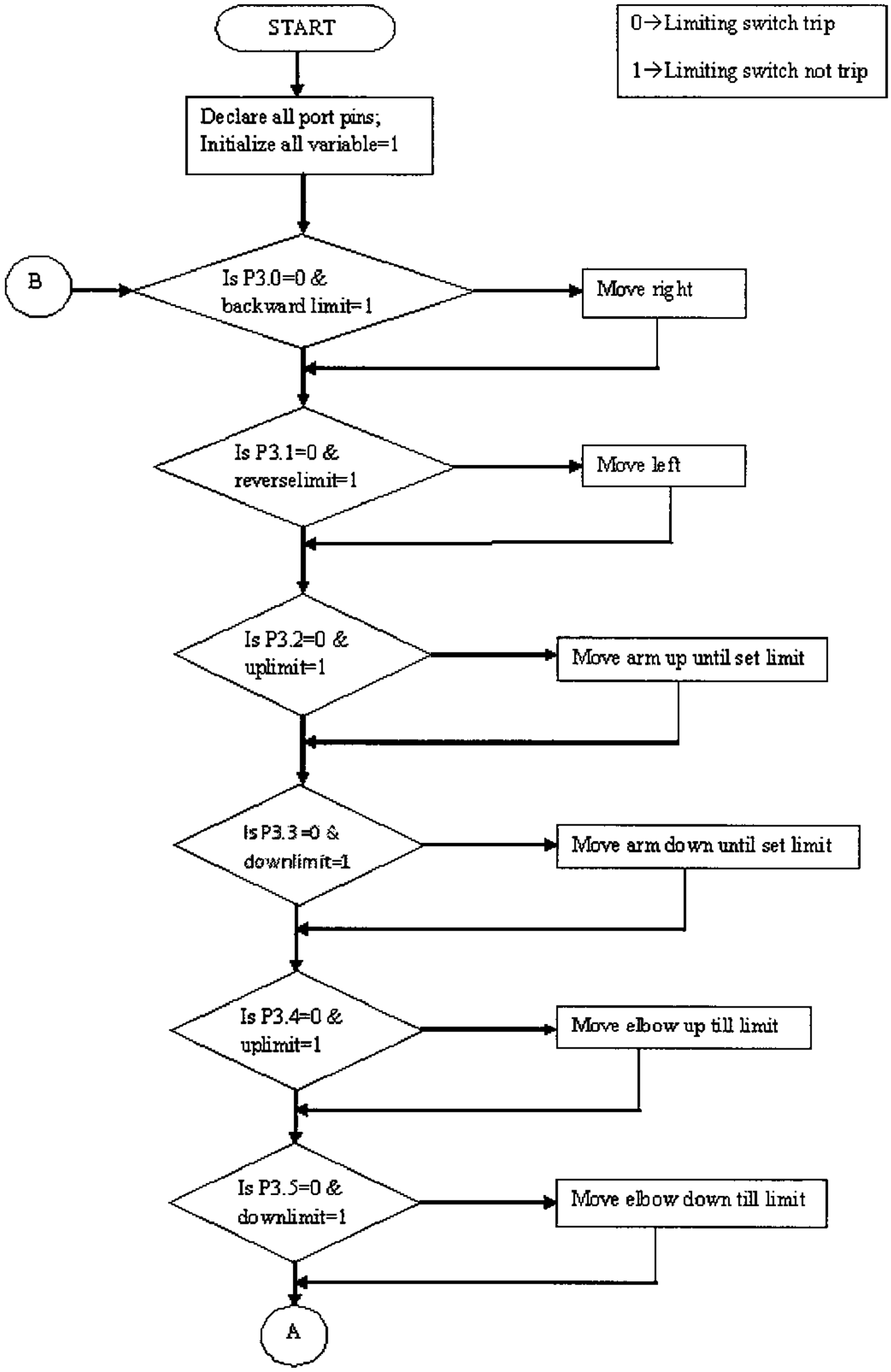
Step 16: If open key is pressed and open limit switch is not tripped, then goto step 17 else goto Step 18.

Step 17: Open the hand.

Step 18: Set all limit bits to 1 (Limits disabled).

Step 19: Goto step 2.

4.4. FLOW CHART:



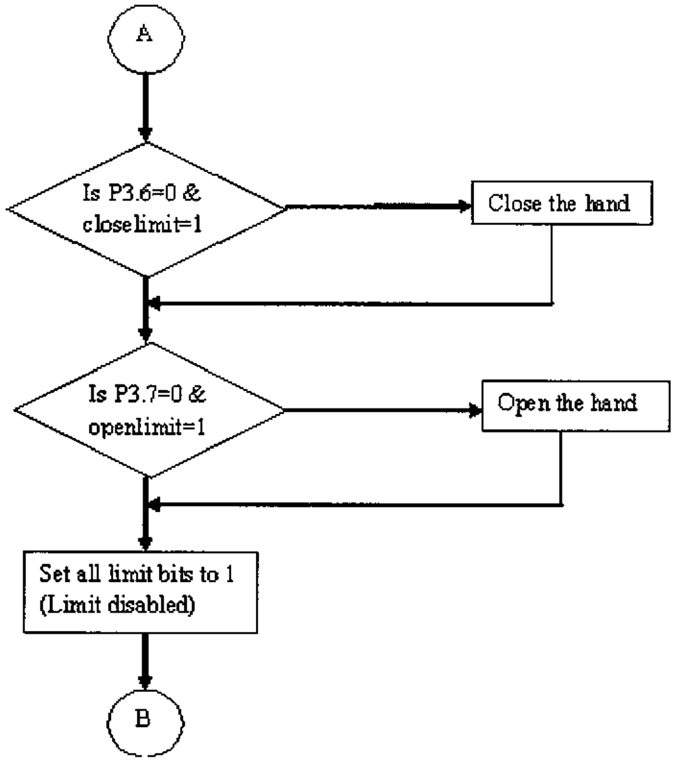


Fig.4.7. Flow chart of Pick and Place Robot Mechanism

CHAPTER 5

PCB DESIGNING PROCESS

5.1. PRINTED CIRCUIT BOARD:

Making of printed circuit boards is as much an art as a technique, particularly when they are to be fabricated in very small numbers. They are several ways of drawing PCB patterns and making the final boards, but the methods most likely to interest people in need of just a few PCBs has to be simple and economical.

The making of a PCB essentially involves two steps:

1. Preparing the PCB drawing.
2. Fabricating the PCB itself from the drawing.

The industrial method of making a PCB drawing with complete placement of parts, taking a photographic negative of the drawing, developing the image of the negative formed on photosensitized copperplate, and dissolving the excess copper by etching is a standard practice being followed in large scale operations. How ever, for small scale operations where large numbers of copies are not required, the cost saving procedure presented here may be adopted.

The procedure has its own advantages, as the lateral inversion problem (discussed later) is over come. Also, tracing of the circuit and fault finding is made easy, as the PCB exactly matches with the original circuit so that one does not have to constantly look for positions to drill holes and place various components.

5.2. PCB DRAWING:

Making of the PCB drawing involves some preliminary considerations such as placement of components (in the same order as the circuit diagram) on a piece of paper, location of holes, deciding the diameters of various holes, the optimum areas each components should occupy, the shape and location of islands for connecting two or more components at a place, full space utilization, and prevention of overcrowding of components at a particularly place. There is no other way to arrive at the correct conclusions than by trail and error. For anchoring leads of components 1mm diameter holes, and for fixing PCB holding screws to the chassis 3mm diameter holes, are recommended.

This sketch may be redrawing neatly on a fresh piece of paper, if desired. This sketch is the mirror image of the PCB pattern desired; it shows the components Placements on the other side of the PCB laminate.

The mirror image of this sketch, the PCB pattern, can now be drawn with the help of a thick tracing paper. The sketch is redrawn on a tracing paper wouldn't appears as a PCB pattern when viewed from the other side. To save time and effort, the sketch may be made on the tracing paper itself right in the beginning.

Alternatively, the PCB pattern can be drawn from the sketch with the help of a carbon paper. A fresh carbon paper may be placed face up on a flat surface and covered with a plain sheet of paper. On this sheet the sketch may be placed. Now, by carefully tracing the sketch with a ball pen or a hard pencil, the, mirror image of the sketch may be obtained on the lower sheet of paper.

5.3. PCB FABRICATION:

The copper-clad PCB laminate may now be prepared by rubbing away the oxide, grease and dirt etc with a fine emery paper or sandpaper. On this the final PCB drawing may be traced this time by using the carbon paper in the normal way (face down on the laminate). Clips should be used to prevent the carbon and the paper from slipping while the PCB pattern is being traced on the laminate. Only the connecting lines in PCB islands and holds should be traced the positions of Components a need not be traced. The components positions can be marked on the PCB reverses side, if desired.

CHAPTER 6
TESTING AND DISCUSSION

6.1. INTRODUCTION:

Testing is an important phase in doing a project. The testing should be done during each and every stage of the project to avoid failure of the whole mechanism due to the fault in a module. This can cause loss in terms of money and also manual work. Hence careful testing should be done.

In this project testing is done in the following modules: power supply module, stepper motor along with its driver, DC motor along with its driver, keypad. The power supply module is tested for its output and on the basis of the output it is given to the corresponding devices. The stepper motor and DC motors are tested for their rotation. Based on the output the step angle and the speed can be varied as needed for the project. Further the response for a particular key pressed in keypad which is interfaced to the microcontroller and the maximum weight the particular robot mechanism can pick is also tested.

6.2. PERFORMANCE:

There are two power supply modules designed in this project. The power supply module is tested by giving the input from a 230V AC supply. The output is tested using a millimeter. If the output is 5V DC then it is given to supply microcontroller and other ICs. If the output is 12V then it is given to DC motor driver circuit.

The pulses are given to the stepper driver by the microcontroller and the movement of the stepper motor in forward and reverse direction i.e. clockwise and anticlockwise rotation is tested. Similarly the DC motor rotation is tested by giving command from the stepper motor.

Finally after the project is completed the testing of the operation of the stepper motor is done by pressing the keys on the keypad. . Right key is pressed in keypad, the microcontroller gives forward pulses to the stepper driver and whether it moves the stepper motor towards the right side at a preset step angle is tested. Similarly left key is pressed in keypad, the microcontroller gives reverse pulses to the stepper motor and whether it moves the stepper motor towards the left side at a preset step angle is tested.

Up key is pressed in keypad, signal from microcontroller goes to DC motor driver circuit and whether the DC motor1 moves the arm moves in vertical movement rod up till the set limit is tested. Similarly when down key is pressed and whether the DC motor 1 moves the arm in the vertical movement rod down till the set limit is tested.

The elbow up key is pressed in the keypad and whether the DC motor2 moves up the forearm up at an angle till the set limit is tested. Similarly elbow down key is pressed in the keypad and whether the DC motor2 moves down the forearm at an angle down till the set limit is tested.

The open key is pressed in the keypad and whether the DC motor3 opens the gripper till the set limit is tested. Similarly, close key is pressed in the keypad and whether the DC motor3 closes the gripper till the set limit is tested.

The maximum weight the Pick and Place Robot can pick is also tested. The Pick and Place Robot designed in this project can pick a maximum weight of 200 grams.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

CONCLUSION:

The pick and place robot designed in this project is successfully tested. This can be used in many industrial applications such as picking and placing bricks, containers, tyres and other heavy objects.

This project is a semi automation process. This can be fully automated by interfacing with computer. Automated pick and place laser soldering robot can solder the materials using laser beam. Further the quality of the material can also be tested while picking and defective items can be discarded.

FUTURE SCOPE:

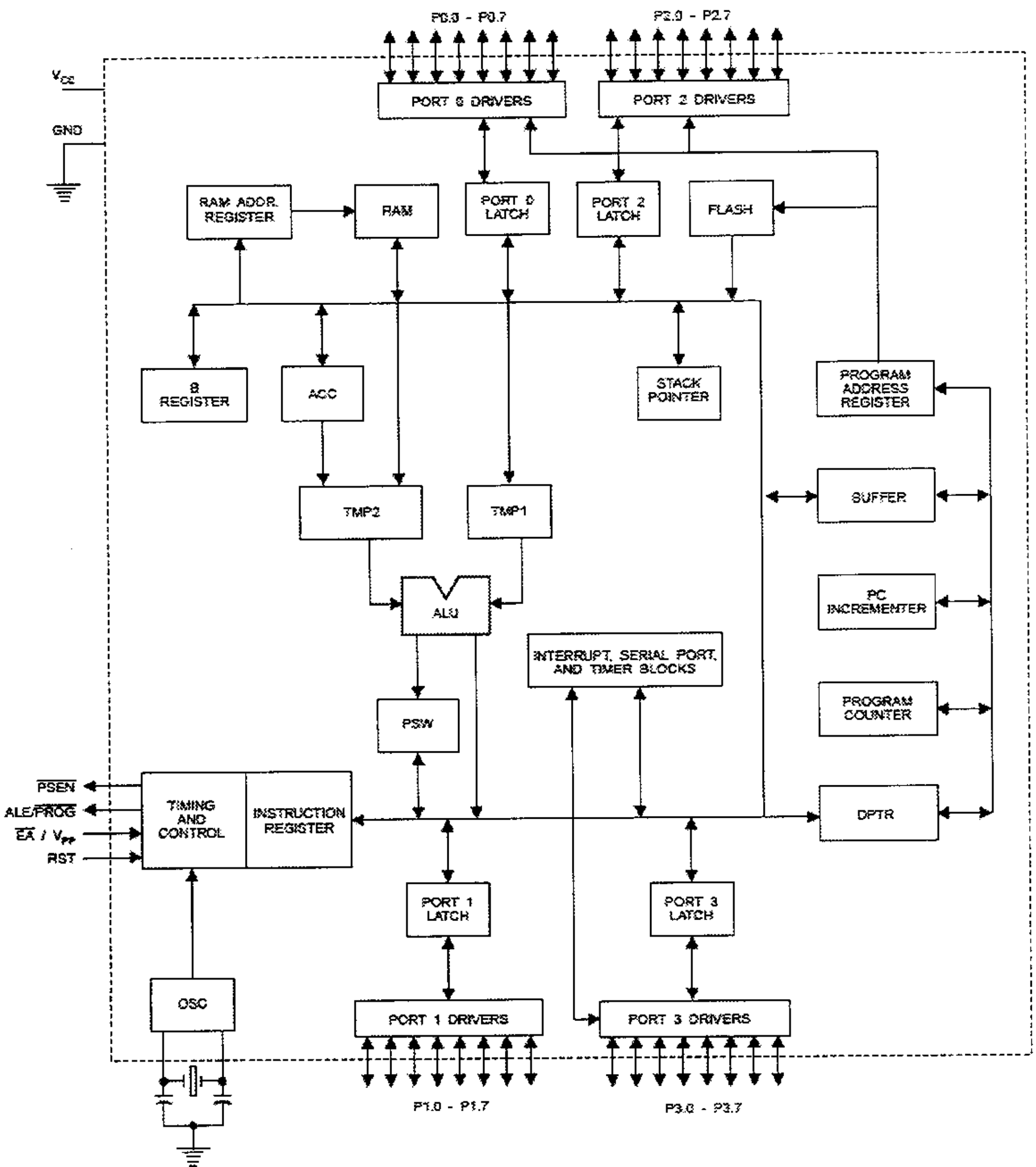
In future, pick and place robot implanted with sensors can also be used in pharmaceutical industry for picking industry for picking individual components out of hundreds of components that may be stored in compound library.

As a extension of our project, several arms can be made to work simultaneously from a socket network. This increases the mobility and ability to conduct multiple tasks.

APPENDIX A
HARDWARE

Microcontroller(ATMEL 89C1):

ARCHITECTURE:



Architecture of AT89C51

POWER MODES OF ATMEL 89C51:

To exploit the power savings available in CMOS circuitry Atmel 's Flash micro controllers have software-invited reduced power modes.

IDLE MODE:

The CPU is turned off while the RAM and other on - chip peripherals continue operating. Inn this mode current draw is reduced to about 15 percent of the current drawn when the device is fully active.

POWER DOWN MODE:

All on-chip activities are suspended while the on – chip RAM continues to hold its data. In this mode, the device typically draws less than 15 Micro Amps and can be as low as 0.6 Micro Amps

POWER ON RESET:

When power is turned on, the circuit holds the RST pin high for an amount of time that depends on the capacitor value and the rate at which it charges.

To ensure a valid reset, the RST pin must be held high long enough to allow the oscillator to start up plus two machine cycles. On power up, Vcc should rise within approximately 10ms. The oscillator start-up time depends on the oscillator frequency. For a 10 Mhz crystal, the start-up time is typically 1ms.With the given circuit, reducing Vcc quickly to 0 causes the RST pin voltage to momentarily fall below 0V. How ever, this voltage is internally l limited and will not harm the device.

ADDRESSING MODES:

DIRECT ADDRESSING:

In direct addressing, the operand specified by an 8-bit address field in the instruction. Only internal data RAM and SFR's can be directly addressed.

INDIRECT ADDRESSING:

In Indirect addressing, the instruction specifies a register that contains the address of the operand. Both internal and external RAM can indirectly address.

The address register for 8-bit addresses can be either the Stack Pointer or R0 or R1 of the selected register Bank. The address register for 16-bit addresses can be only the 16-bit data pointer register, DPTR.

INDEXED ADDRESSING:

Program memory can only be accessed via indexed addressing this addressing mode is intended for reading look-up tables in program memory. A 16 bit base register (Either DPTR or the Program Counter) points to the base of the table, and the accumulator is set up with the table entry number. Adding the Accumulator data to the base pointer forms the address of the table entry in program memory.

Another type of indexed addressing is used in the" case jump " instructions. In this case the destination address of a jump instruction is computed as the sum of the base pointer and the Accumulator data.

REGISTER INSTRUCTION:

The register banks, which contains registers R0 through R7, can be accessed by instructions whose opcodes carry a 3-bit register specification. Instructions that access the registers this way make efficient use of code, since this mode eliminates an address byte. When the instruction is executed, one of four banks is selected at execution time by the row bank select bits in PSW.

REGISTER - SPECIFIC INSTRUCTION:

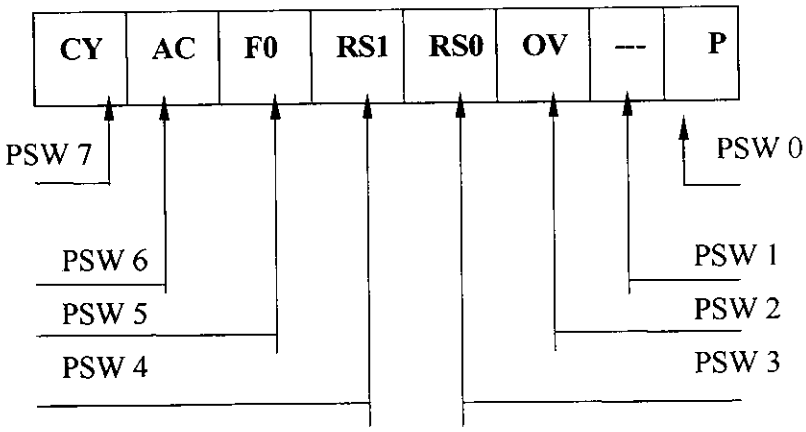
Some Instructions are specifiec to a certain register. For example some instruction always operates on the Accumulator, so no address byte is needed to point OT ir. Inthese cases, the opcode itself points to the correct register. Instruction that regger to Accumulator as A assemble as Accumulator - specific Opcodes.

IMMEDIATE CONSTANTS:

The value of a constant can follow the opcode in program memory For example. MOV A, #100 loads the Accumulator with the decimal number 100. The same number could be specified in hex digit as 64h.

PROGRAM STATUS WORD:

Program Status Word Register in Atmel Flash Micro controller:



PSW 0: Parity of Accumulator Set By Hardware To 1 if it contains an Odd number of 1s, Otherwise it is reset to 0.

PSW1: User Definable Flag

PSW2: Overflow Flag Set By Arithmetic Operations

PSW3: Register Bank Select

PSW4: Register Bank Select

PSW5: General Purpose Flag.

PSW6: Auxiliary Carry Flag Receives Carry Out from Bit 1 of Addition Operands

PSW7: Carry Flag Receives Carry Out From Bit 1 of ALU Operands.

The Program Status Word contains Status bits that refklect the current stae of the CPU. The PSW shown if Fig resides in SFR space. The PSW cònrains the Carry Bit, The auxillary Carry (For BCD Operations) the two - register bank select bits, the Overflow flag, a Parity bit and two user Definable status Flags.

The Carry Bit, in addition to serving as a Carry bit in arithmetic operations also serves the as the “Accumulator” for a number of Boolean Operations .The bits RS0 and RS1 select one of the four register banks. A number of instructions register to these RAM locations as R0 through R7.The status of the RS0 and RS1 bits at execution time determines which of the four banks is selected.

The Parity bit reflect the Numer of 1s in the Accumulator .P=1 if the Accumulator conrains an even number of 1s, and P=0 if the Accumulator contains an even number of 1s. Thus, the number of 1s in the Accumulator plus P is always even. Two bits in the PSW are uncommitted and can eb used as general-purpose status flags.

INTERRUPTS

The AT89C51 provides 5 interrupt sources: Two External interrupts, two-timer interrupts and a serial port interrupts. The External Interrupts INT0 and INT1 can each either level activated or transistion - activated, depending on bits IT0 and IT1 in Register TCON. The Flags that actually generate these interrupts are the IE0 and IE1 bits in TCON. When the service routine is vectored to hardware clears the flag that generated an external interrupt *only* if the interrupt WA transition - activated. If the interrupt was level - activated, then the external requesting source (rather than the on-chip hardware) controls the requested flag. Tf0 and Tf1 generate the Timer 0 and Timer 1 Interrupts, which are set by a rollover in their respective Timer/Counter Register (except for Timer 0 in Mode 3). When a timer interrupt is generated, the on-chip hardware clears the flag that generated it when the service routine is vectored to. The logical OR of RI and TI generate the Serial Port Interrupt. Neither of these floag is cleared by hardware when the service routine is vectored to. In fact, the service routine normally must determine whether RI or TI generated the interrupt an the bit must be cleared in software.

In the Serial Port Interrupt is generated by the logical OR of RI and TI. Neither of these floag is cleared by hardware when the service toutine is vectored to. In fact, the service routine normally must determine whether RI to TI generated the interrupt and the bit must be cleared in software.

IE: Interrupt Enable Register

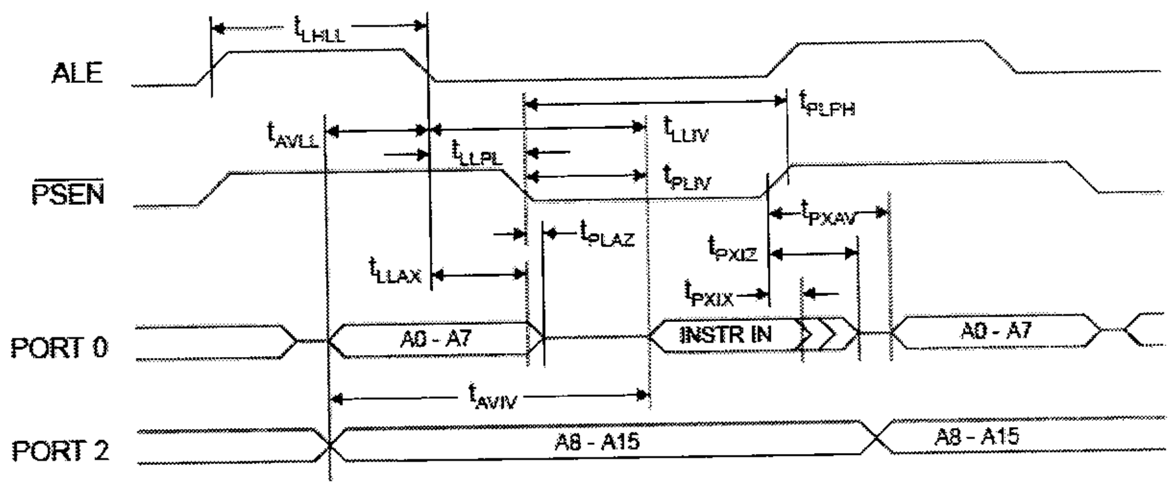
EA	**-**	**ET2**	**ES**	**ET1**	**EX1**	**ET0**	**EX0**

Enable bit = 1 enabled the interrupt

Enable bit = 0 diables it.

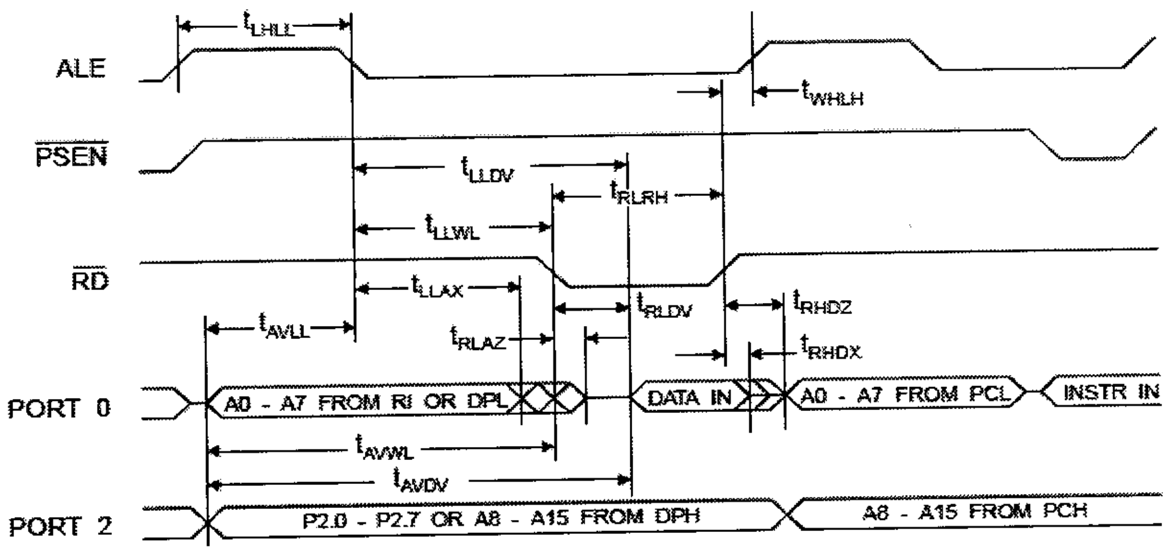
TIMING DIAGRAM:

External Program Memory Read Cycle



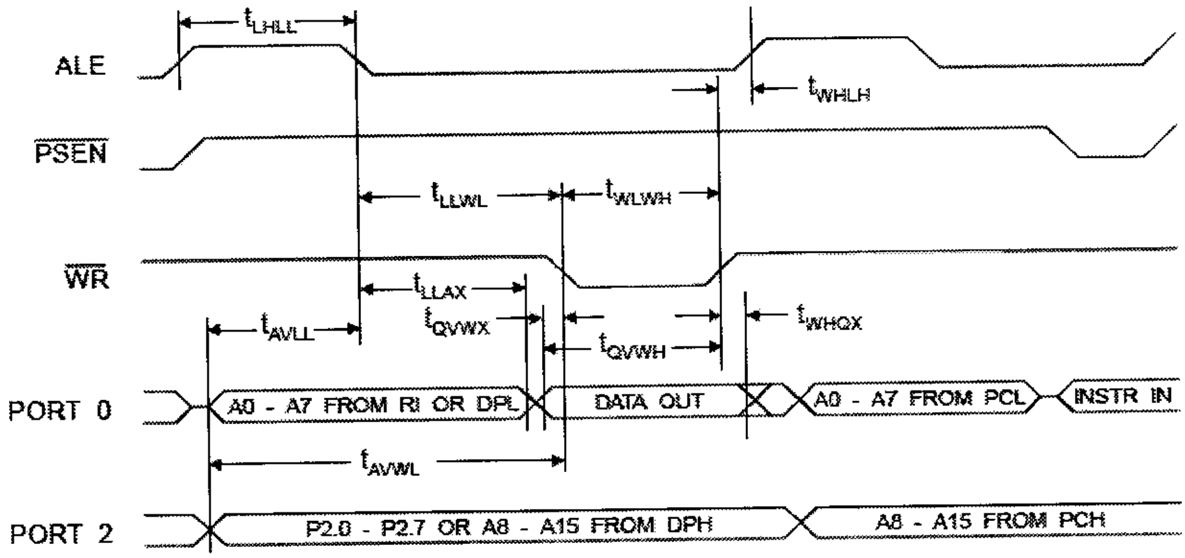
External program memory read cycle

External Data Memory Read Cycle



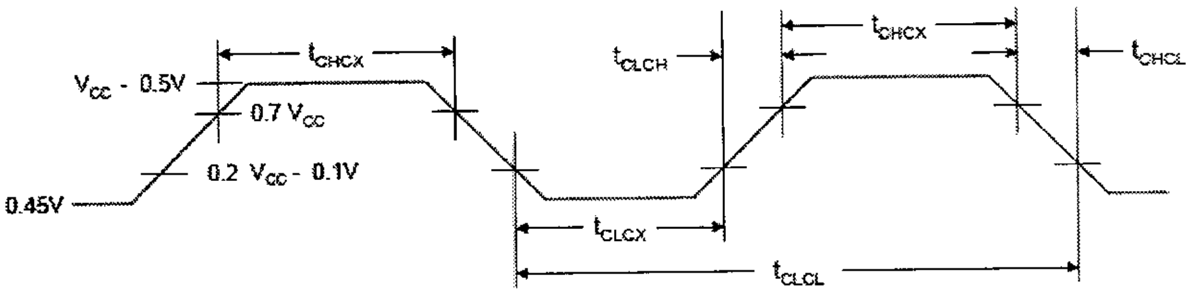
External data memory read cycle

External Data Memory Write Cycle



External data memory write cycle

External Clock Drive Waveforms



External Clock Drive Waveforms

NPN GENERAL PURPOSE TRANSISTORS:

FEATURES:

· Low current (max. 100 mA)

· Low voltage (max. 65 V).

APPLICATIONS

· General purpose switching and amplification.

DESCRIPTION

NPN transistor in a TO-92; SOT54 plastic package.

PNP complements: BC556 and BC557.

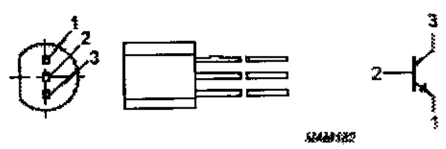


Fig.1 Simplified outline (TO-92; SOT54) and symbol.

PINNING:

PIN	DESCRIPTION
1	emitter
2	base
3	collector

SERIES VOLTAGE REGULATORS:

General Description:

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.

Features:

Output current in excess of 1A
Internal thermal overload protection
No external components required
Output transistor safe area protection
Internal short circuit current limit
Available in the aluminum TO-3 package

Voltage Range:

LM7805C 5V
LM7812C 12V
LM7815C 15V

POSITIVE VOLTAGE REGULATORS:

OUTPUT CURRENT UP TO 1.5 A

OUTPUT VOLTAGESOF 5; 5.2; 6; 8; 8.5; 9;12; 15; 18; 24V

THERMAL OVERLOADPROTECTION

SHORT CIRCUIT PROTECTION

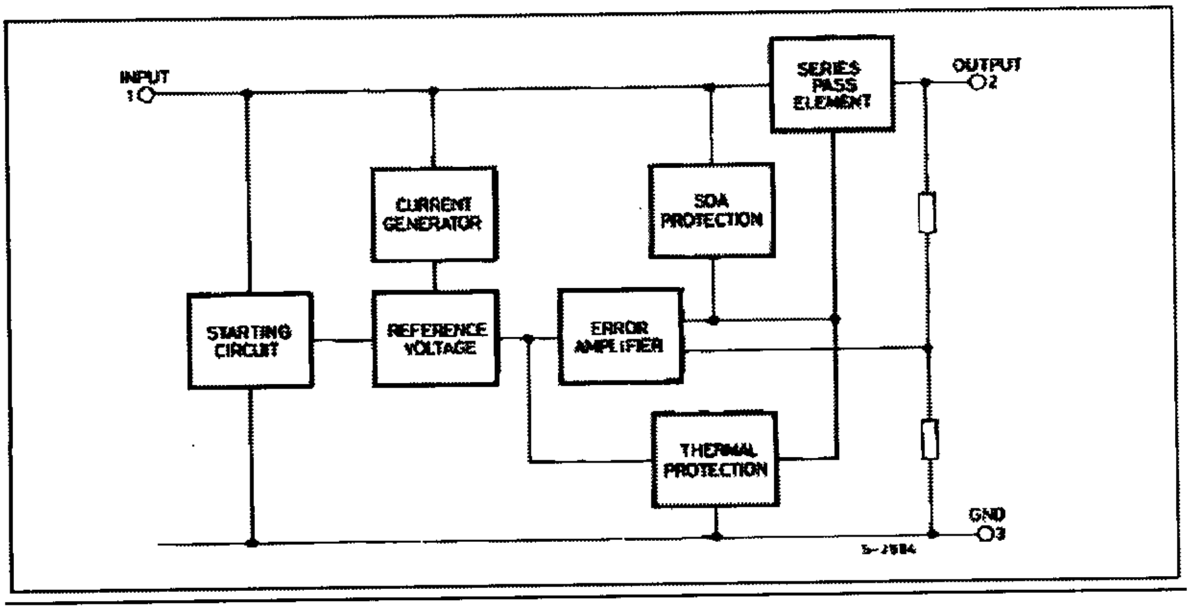
OUTPUT TRANSITION SOA PROTECTION

DESCRIPTION:

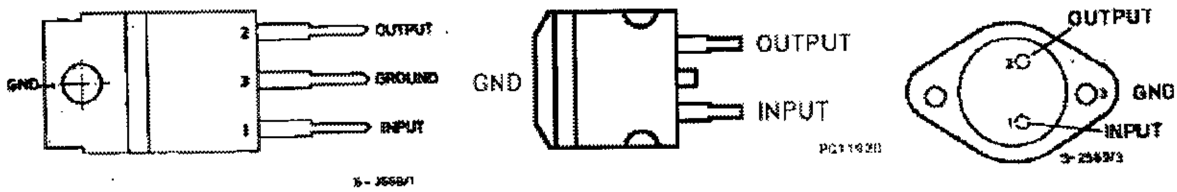
The L7800 series of three-terminal positive regulators is available in TO-220 TO-220FP TO-3 and D2PAK packages and several fixed output voltages, making it useful in a wide range of applications. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation.

Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequateheat sinking is provided, they can deliver over 1A output current.

BLOCK DIAGRAM:



CONNECTION DIAGRAM AND ORDERING NUMBERS (top view)



TO-220 & TO-220FP D^{2}PAK TO-3

APPENDIX B

PROGRAM

Coding:

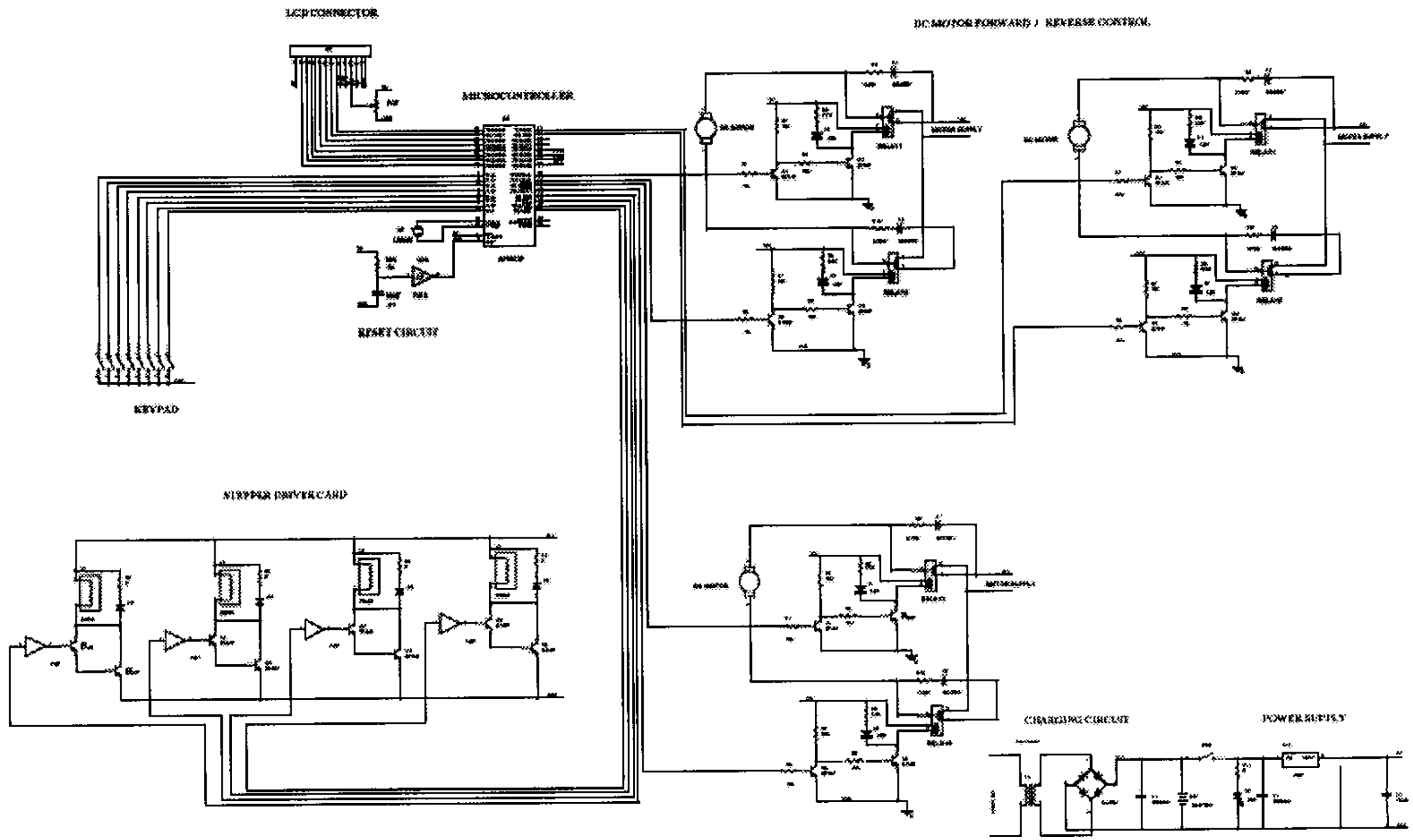
```
#include <AT89X52.H>

sbit pcm=P1^0;
sbit pom=P1^1;
sbit adm=P1^2;
sbit aum=P1^3;
sbit dnm=P1^4;
sbit upm=P1^5;

sbit pcl=P1^6;
sbit aul=P0^0;
sbit adl=P0^1;
sbit upl=P0^2;
sbit dnl=P0^3;
sbit bfl=P0^4;
sbit brl=P1^7;

void delay(unsigned int);
void delay1(unsigned int);
void forward();
void reverse();

void main()
{
        while(1)
        {
                if(P3==0xfe && bfl){forward();}
                else if(P3==0xfd && brl){reverse();}
                else if(P3==0xfb && upl){upm=0;}
                else if(P3==0xf7 && dnl){dnm=0;}
```

```
            else if(P3==0xef && aul){aum=0;}
            else if(P3==0xdf && adl){adm=0;}
            else if(P3==0xbf && pcl){pcm=0;}
            else if(P3==0x7f){pom=0;}
            else {upm=dnm=aum=adm=pcm=pom=1;}
        }
}

void forward()
{
        P2=0x05;
        delay1(3000);
        P2=0x09;
        delay1(3000);
        P2=0x0a;
        delay1(3000);
        P2=0x06;
        delay1(3000);
}

void reverse()
{
        P2=0x06;
        delay1(3000);
        P2=0x0a;
        delay1(3000);
        P2=0x09;
        delay1(3000);
        P2=0x05;
        delay1(3000);
}
```

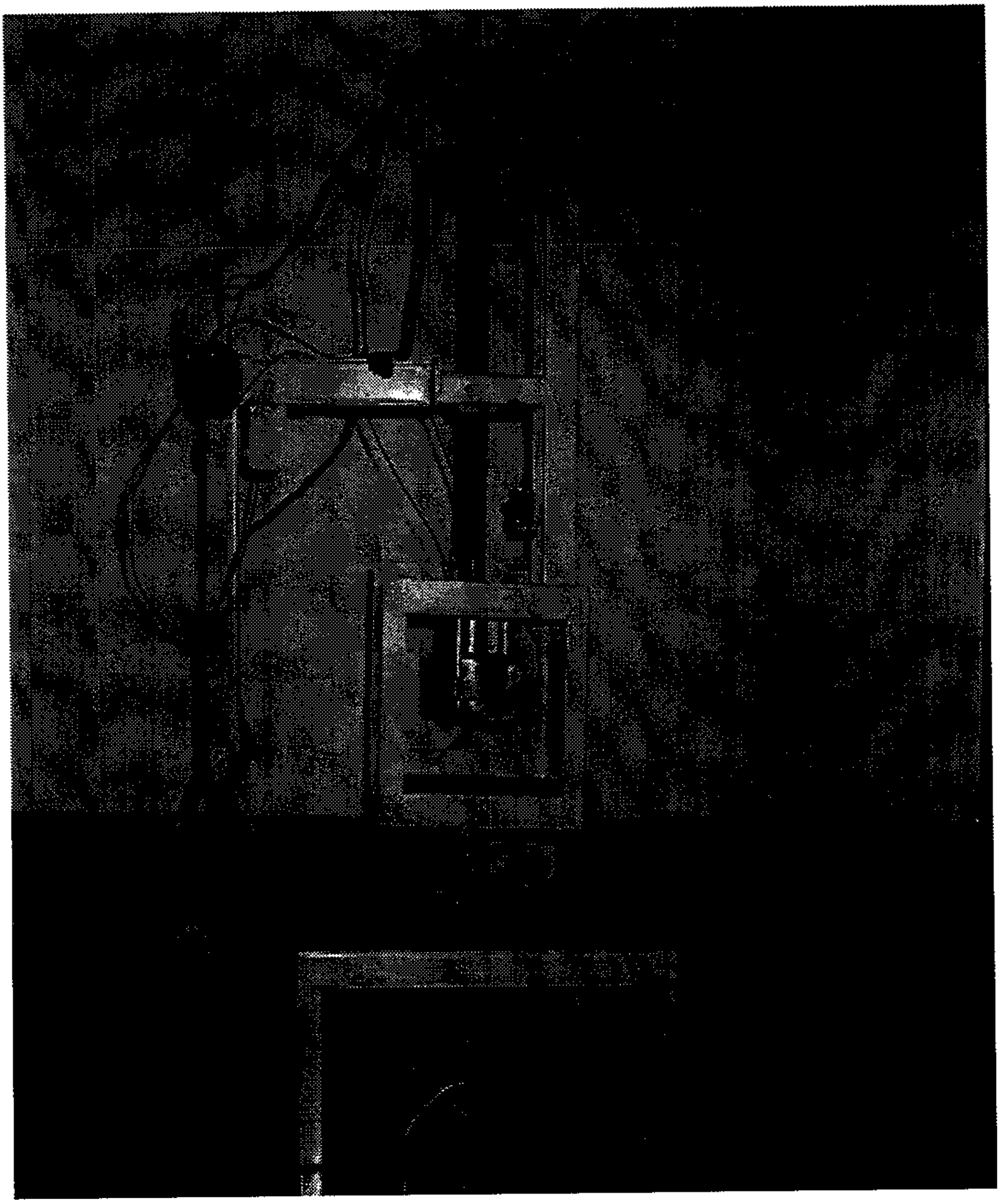
```
void delay1(unsigned int dy)
{
	while(dy--)
	{
		if(!bfl || !brl){delay(4000);P2=0x00;delay(4000);break;}
	}
}

void delay(unsigned int dy)
{
	while(dy--);
}
```

APPENDIX C
CIRCUIT DIAGRAM

OVERALL CIRCUIT DIAGRAM



PHOTOGRAPH:



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15. www.rec.ri.cmu.edu/education/**robot**icscurriculum/ introductiontohardware.htm