Chapter 3

3.1 Overview :-

Microcontroller is a computer on a chip that is programmed to perform almost any control, sequencing, monitoring and display the function. Because of its relatively low cost, it becomes the natural choice to the designer. Microcontroller is designed to be all of that in one. Its great advantage is no other external components are needed for its application because all necessary peripherals are already built into it. Thus, we can save the time, space and cost which is needed to construct low cost devices [15].

Even at a time when Intel presented the first microprocessor with the 4004 there was already a demand for microcontrollers: The contemporary TMS1802 from Texas Instruments, designed for usage in calculators, was by the end of 1971 advertised for applications in cash registers, watches and measuring instruments. The TMS 1000, which was introduced in 1974, already included RAM, ROM, and I/O on-chip and can be seen as one of the first microcontrollers, even though it was called a microcomputer.

The first controllers to gain really widespread use were the Intel 8048, which was integrated into PC keyboards, and its successor, the Intel 8051, as well as the 68HCxx series of microcontrollers from Motorola.

Today, microcontroller production counts are in the billions per year, and the controllers are integrated into many appliances we have grown used like to:

1. household appliances (microwave, washing machine, coffee machine, . . .)
2. telecommunication (mobile phones)
3. automotive industry (fuel injection, ABS, . . .)

4. aerospace industry
5. industrial automation

3.2 Features:-

   a. High-performance, Low-power Atmel® AVR® 8-bit Microcontroller.
   b. Advanced RISC Architecture.
   c. High Endurance Non-volatile Memory segments.

2. In-System Programming by On-chip Boot Program.
3. True Read-While-Write Operation.
4. Single-ended Channels
5. Differential Channels in TQFP Package Only
6. I/O and Packages
   a. Operating Voltages:
   b. Speed Grades:
   c. Power Consumption at 1 MHz, 3V, 25·C
7. Pin Configurations

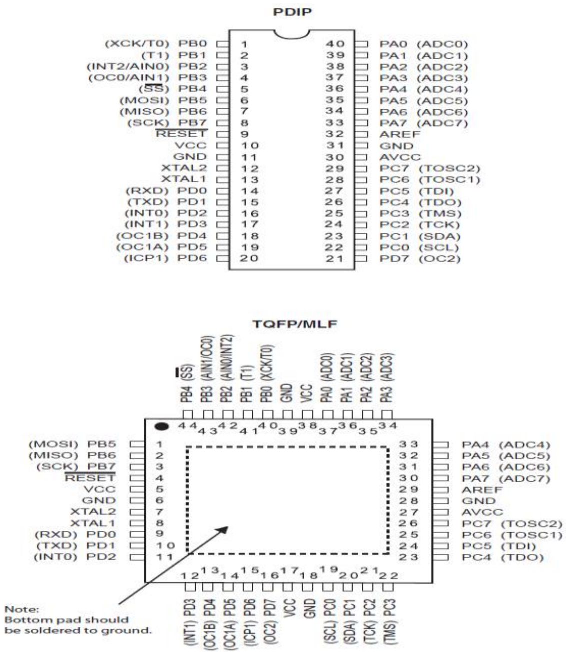


Figure 3.1. Pin out ATmega32

The Atmel® AVR® ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

The Atmel® AVR® core combines a rich instruction set with 32 general purpose working registers[2].

All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega32 provides the following features: 32Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024bytes EEPROM, 2Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run.

The device is manufactured using Atmel’s high density nonvolatile memory technology. The On chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega32 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.

The Atmel AVR ATmega32 is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

3.4 Pin Descriptions :

VCC : Digital supply voltage.

GND : Ground.

Port A (PA7..PA0) Port A serves as the analog inputs to the A/D Converter.

Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B also serves the functions of various special features of the ATmega32 as listed on Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

The TD0 pin is tri-stated unless TAP states that shift out data are entered.

Port C also serves the functions of the JTAG interface and other special features of the ATmega32 as listed on Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D also serves the functions of various special features of the ATmega32 as listed on RESET: Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is . Shorter pulses are not guaranteed to generate a reset.

XTAL1: Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting Oscillator amplifier.

AVCC: AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: AREF is the analog reference pin for the A/D Converter.

3.1.6Data Retention Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.

3.5 AVR CPU Core

This section discusses the Atmel®AVR® core architecture in general. The main function of the CPU core is to ensure correct program execution. The CPU must therefore be able to access memories, perform calculations, control peripherals, and handle interrupts.

In order to maximize performance and parallelism, the AVR uses a Harvard architecture – with separate memories and buses for program and data. Instructions in the program memory are executed with a single level pipelining. While one instruction is being executed, the next instruction is pre-fetched from the program memory. This concept enables instructions to be executed in every clock cycle. The program memory is In-System Reprogrammable Flash memory[14].

The fast-access Register File contains 32 × 8-bit general purpose working registers with a single clock cycle access time. This allows single-cycle Arithmetic Logic Unit (ALU) operation. In a typical ALU operation, two operands are output from the Register File, the operation is executed, and the result is stored back in the Register File – in one clock cycle.

Six of the 32 registers can be used as three 16-bit indirect address register pointers for Data Space addressing – enabling efficient address calculations. One of the these address pointers can also be used as an address pointer for look up tables in Flash Program memory. These added function registers are the 16-bit X-, Y-, and Z-register, described later in this section Six of the 32 registers can be used as three 16-bit indirect address register pointers for Data Space addressing – enabling efficient address calculations. One of the these address pointers can also be used as an address pointer for look up tables in Flash Program memory. These added function registers are the 16-bit X-, Y-, and Z-register, described later in this section. The ALU supports arithmetic and logic operations between registers or between a constant and a register. Single register operations can also be executed in the ALU. After an arithmetic operation, the Status Register is updated to reflect information about the result of the operation.

Program flow is provided by conditional and unconditional jump and call instructions, able to directly address the whole address space. Most AVR instructions have a single 16-bit word format.

Every program memory address contains a 16-bit or 32-bit instruction.

Program Flash memory space is divided in two sections, the Boot program section and the Application Program section. Both sections have dedicated Lock bits for write and read/write protection. The SPM instruction that writes into the Application Flash memory section must reside in the Boot Program section.

During interrupts and subroutine calls, the return address Program Counter (PC) is stored on the Stack. The Stack is effectively allocated in the general data SRAM, and consequently the Stack size is only limited by the total SRAM size and the usage of the SRAM. All user programs must initialize the SP in the reset routine (before subroutines or interrupts are executed). The Stack Pointer SP is read/write accessible in the I/O space. The data SRAM can easily be accessed through the five different addressing modes supported in the AVR architecture.

The memory spaces in the AVR architecture are all linear and regular memory maps.

A flexible interrupt module has its control registers in the I/O space with an additional global interrupt enable bit in the Status Register. All interrupts have a separate interrupt vector in the interrupt vector table. The interrupts have priority in accordance with their interrupt vector position .The lower the interrupt vector address, the higher the priority.

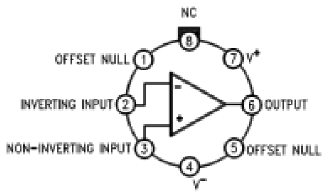
3.6 Operation amplifier (LM741 Operational Amplifier):-

Overload Protection on the Input and Output No Latch-Up When the Common Mode Range is Exceeded DESCRIPTION The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications[15].

The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C is identical to the LM741/LM741A except that the LM741C has their performance ensured over a 0°C to +70°C temperature range, instead of −55°C to +125°C.

LM741H is available per JM38510/10101:



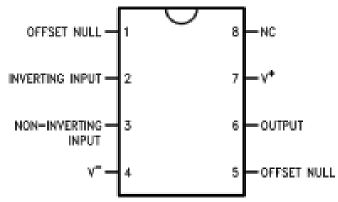


Figure 3.2. TO-99 Package   Figure 3. 3. CDIP or PDIP Package

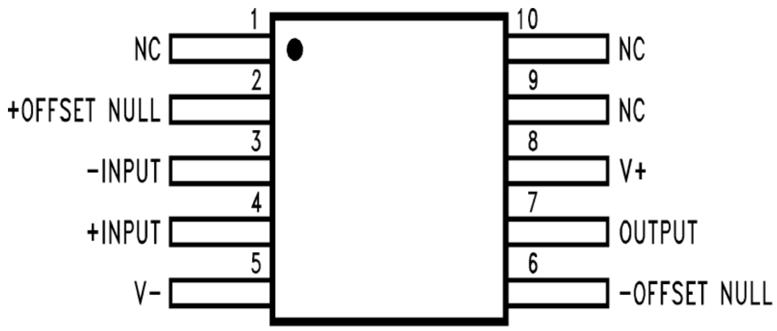


Figure 3.4 CLGA Package See Package Number NAD0010A

Typical Application:

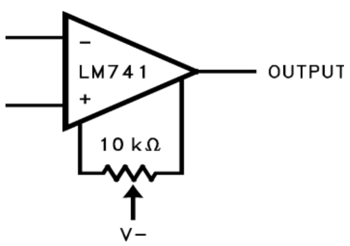


Figure 3.2. Offset Nulling Circuit

Table 3.1: Absolute maximum

Absolute Maximum Ratings [1][2][3]

	LM741A	LM741	LM741C
Supply Voltage	±22V	±22V	±18V
Power Dissipation [4]	500 mW	500 mW	500 mW
Differential Input Voltage	±30V	±30V	±30V
Input Voltage [5]	±15V	±15V	±15V
Output Short Circuit Duration	Continuous	Continuous	Continuous
Operating Temperature Range	−55°C to +125°C	−55°C to +125°C	0°C to +70°C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C
Junction Temperature	150°C	150°C	100°C
Soldering Information			
P0008E-Package (10 seconds)	260°C	260°C	260°C
NAB0008A- or LMC0008C-Package (10 seconds)	300°C	300°C	300°C
M-Package			
Vapor Phase (60 seconds)	215°C	215°C	215°C
Infrared (15 seconds)	215°C	215°C	215°C
ESD Tolerance [6]	400V	400V	400V

(1) “Absolute Maximum Ratings” indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits.

(2) For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.

(4) For operation at elevated temperatures, these devices must be derated based on thermal resistance, and Tj max. (listed under “Absolute Maximum Ratings”). Tj = TA + (θjA PD).

(5) For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

(6) Human body model, 1.5 kΩ in series with 100 pF.

(1) Unless otherwise specified, these specifications apply for VS = ±15V, −55°C ≤ TA ≤ +125°C (LM741/LM741A). For the LM741C/LM741E, these specifications are limited to 0°C ≤ TA ≤ +70°C

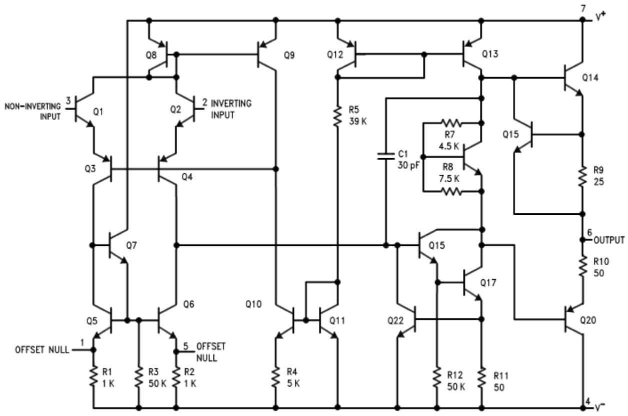


Figure3.2 : Schematic Diagram of Amplifier LM741A

3.4 Pressure sensor

Pressure sensors are used to monitor the pressure of fluids in pipes, hydraulics, engines and in nature. Specialized sensors are also used in order to determine the pressure of gases or solids. Most modern pressure sensors work based on piezo resistance. The exerted pressure causes a material to conduct electricity at a certain rate, therefore leading to a specific level of charge flow that is associated with a specific level of pressure. This charge is fed to a wire that leads to a control panel and a display for human analysis. Pressure sensors that use semiconductors as the resistive media conduct more or less electricity based on geometric deformations in their structure[16].

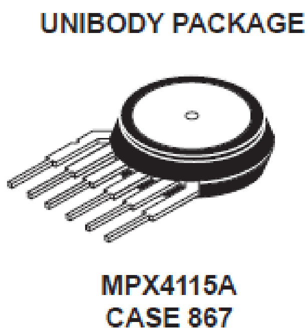


Figure 3.3: Unibody package sensor MPX4115A

3.4.1Types of Pressure Sensors

There are many different kinds of pressure sensors and at Future Electronics, we stock many of the most common types categorized by pressure range, pressure accuracy, pressure type, supply voltage, output type, packaging type and supply current. The parametric filters on our website can help refine your search results depending on the required specifications.

The most common sizes for supply current are 1.5 mA, 6 mA, 7 mA and 10 mA. We also carry pressure sensors with supply current as high as 10000 mA. Supply voltage can be between 1.62 V and 16 V, with the most common pressure sensor chips using a supply voltage of 5 V.

1. Device is radiometric within this specified excitation range.
2. Offset (VOff) is defined as the output voltage at the minimum rated pressure.
3. Full Scale Output (VFSO) is defined as the output voltage at the maximum or full rated pressure.
4. Full Scale Span (VFSS) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
5. Accuracy is the deviation in actual output from nominal output over the entire pressure range and temperature range as a percent of span at 25°C due to all sources of error including the following:

- ❖ Linearity: Output deviation from a straight line relationship with pressure over the specified pressure range.

- Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
- Pressure Hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from minimum or maximum rated pressure at 25°C.
- TcSpan: Output deviation over the temperature range of 0° to 85°C, relative to 25°C.
- TcOffset: Output deviation with minimum pressure applied, over the temperature range of 0° to 85°C, relative to 25°C.

6. Response Time is defined as the time for the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
7. Warm–up Time is defined as the time required for the product to meet the specified output voltage after the pressure has been stabilized.

8. Offset Stability is the product's output deviation when subjected to 1000 cycles of Pulsed Pressure, Temperature Cycling with Bias Test.

3.4.2 Pressure Sensors from Future Electronics

Future Electronics has a full chip selection of pressure sensors from several manufacturers that can be used to design an air pressure sensor, oil pressure sensor, MEMS pressure sensor, digital pressure sensor, barometric pressure sensor, absolute pressure sensor, piezo resistive pressure sensor, water pressure sensor, fuel tank or fuel rail pressure sensor, tactile pressure sensor, brake pressure sensor, tire pressure sensor, miniature or micro pressure sensor, optical pressure sensor, wireless pressure sensor, low / high pressure sensor, liquid pressure sensor, high temperature pressure sensor, gas pressure sensor, automotive pressure sensor, capacitive pressure sensor, steam pressure sensor, atmospheric pressure sensor or for any circuit that might require an electronic pressure sensor. Simply choose from the pressure sensor technical attributes below and your search results will quickly be narrowed to match your specific pressure sensor application needs[16].

If you have a preferred brand, we deal with Bosch, Free scale Semiconductor, GE Measurement & Control, Measurement Specialties, Molex is or Panasonic Electric Works as chip manufacturers. You can easily refine your pressure sensor product search results by clicking your preferred pressure sensor brand below from our list of manufacturers.

3.4.3Applications for Pressure Sensors:

There are many applications for pressure sensors. They can be useful in aircraft, automobiles, weather instrumentation and any other machinery that has pressure functionality implemented. They can also be used to sense altitude in aircraft, rockets, satellites and weather balloons. Another application for pressure sensors is in measuring flow. A pressure sensor may also be used to calculate the level of a fluid, for example to measure the depth of a submerged body or level of contents in a tank. Pressure sensors can also be used in order to sense a loss of pressure due to a system leak.

3.4.4Choosing the Right Pressure Sensor:

When you are looking for the right pressure sensors, with the FutureElectronics.com parametric search, you can filter the results by various attributes: by Pressure Type (Absolute, Differential, Gauge), Supply Current (0.0009 mA, 1.5 mA, 6 mA, 7 mA, 10 mA …) and

Supply Voltage (up to 16 V) to name a few. You will be able to find the right semiconductor chip from several manufacturers that can be used to design an oil pressure sensor, MEMS pressure sensor, air pressure sensor, digital pressure sensor, barometric pressure sensor, absolute pressure sensor, tactile pressure sensor, brake pressure sensor, piezoresistive pressure sensor, water pressure sensor, fuel tank or fuel rail pressure sensor, tire pressure sensor, miniature or micro pressure sensor, optical pressure sensor, liquid pressure sensor, high temperature pressure sensor, wireless pressure sensor, low / high pressure sensor, gas pressure sensor, atmospheric pressure sensor, automotive pressure sensor, capacitive pressure sensor, steam pressure sensor or for any circuits requiring an electronic pressure sensor[16].

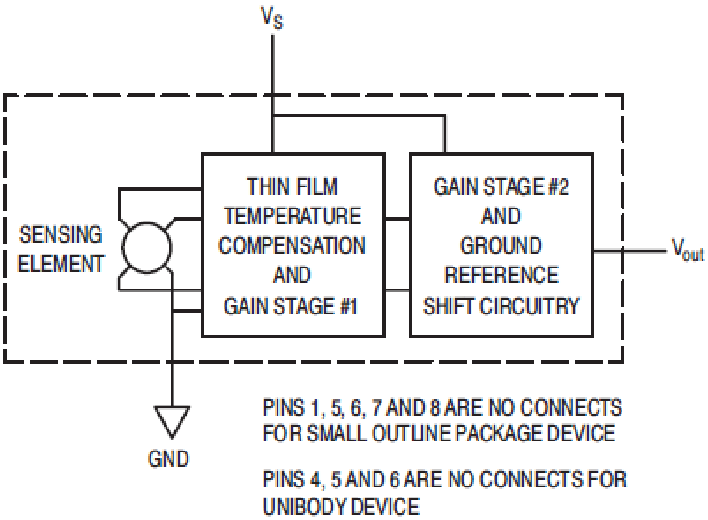


Figure 3.4 Fully Integrated Pressure Sensor Schematic

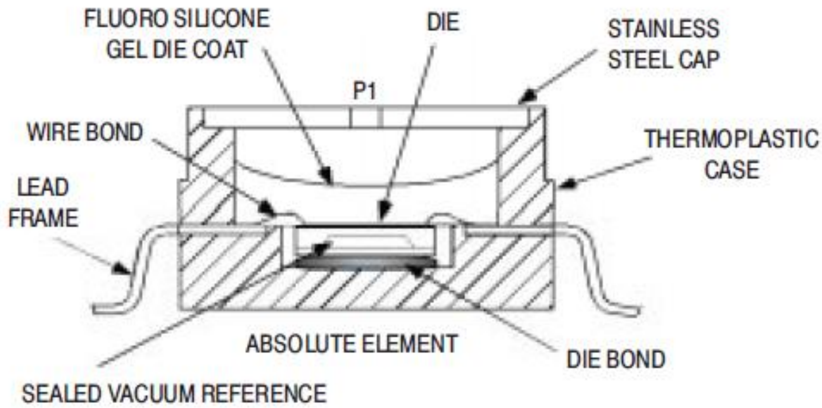


Figure 3.5 illustrates the absolute sensing chip in the basic chip carrier

3.4.5Pressure Sensors in Production Ready Packaging or R&D Quantities

If the quantity of pressure sensors required is less than a full reel, we offer customers many of our pressure sensor products in tube, tray or individual quantities that will avoid unneeded surplus.

In addition, Future Electronics offers clients a unique bonded inventory program that is designed to eliminate potential problems that may arise from an unpredictable supply of products containing raw metals and products with erratic or long lead times.

3.4.6 EFFECTS OF OFFSET ERRORS:

Figure 3.6 illustrates the transfer function of an integrated pressure sensor. It is expressed by the linear function:

VOUT = VOFF + [(VFSO - VOFF)/(PMAX - PREF)] P = VOFF + S P

Here, VOUT is the voltage output of the sensor, VFSO is the full-scale output, VOFF is the offset, PMAX is the maximum pressure and PREF is the reference pressure. Note that (VFSO = -VOFF/PMAX - PREF) can be thought of as the slope of the line and VOFF as they y-intercept. The slope is also

referred to as the sensitivity, S, of the sensor

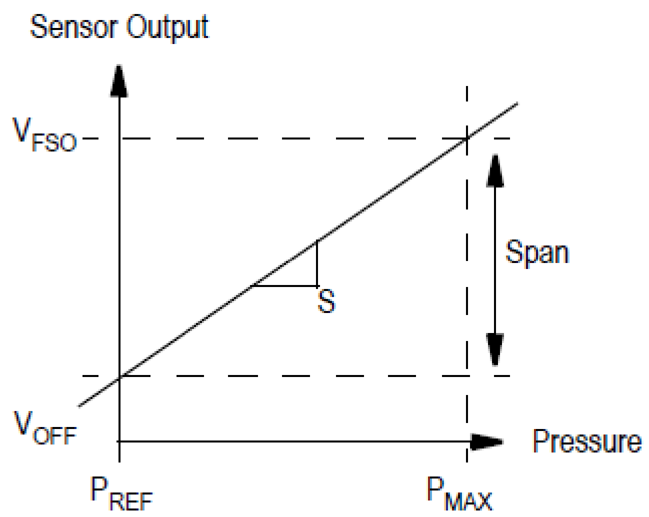


Figure 3.6. Definition of Span, Full-Scale Output, Offset and Sensitivity

A two-point pressure calibration can be performed to accurately determine the sensitivity and get rid of the offset calibration errors altogether. However, this can be very expensive in a high volume production due to extra time and labor involved. The system designer therefore designs a pressure sensor system by relying on the sensitivity and offset data given in the data sheet and using a linear equation to determine the pressure. Using the later, the device variation, mechanical stresses, or offset shift due to temperature (the offset has a temperature coefficient or TCO), those errors will show up as an error, daltaP, in the pressure reading:

P+ΔP = [VOUT − (VOFF +VOFF)]/S

As evident in Figure 3. 5b, offset errors, VOFF, have the effect of moving the intercept up and down *without* affecting the sensitivity. *We can therefore correct this error by sampling the pressure at zero reference pressure (atmosphere)* and *subtracting this from the sensor output.*

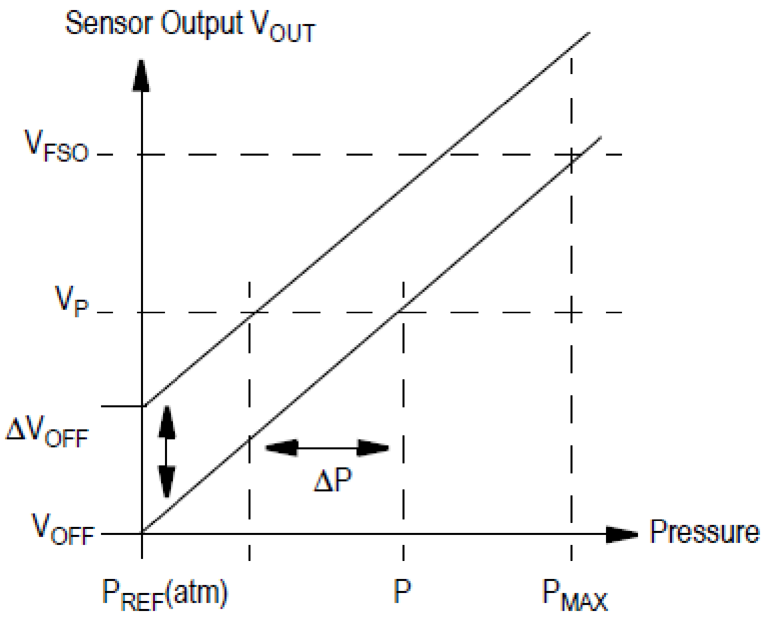


Figure 3.7. Effect of Offset Errors

3.5 Amplitude Shift keying (ASK):

ASK- in the context of digital communications is a modulation process, which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. Thus the modulated waveform consists of bursts of a sinusoid binary ASK signal (lower), together with the binary sequence which initiated it (upper). Neither signal has been band limited. There are sharp discontinuities shown at the transition points. These result in the signal having an unnecessarily wide bandwidth. Band limiting is generally introduced before transmission, in which case these discontinuities would be 'round off'. The band limiting may be applied to the digital message, or the modulated signal itself. The data rate is often made a sub-multiple of the carrier frequency. One of the disadvantages of ASK, compared with FSK and PSK, for example, is that it has not got a constant envelope. This makes its processing (e.g., power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector[15].

3.5.1Circuit Description Power supply:

Power supply unit consists of Step down transformer, Rectifier, Input filter, Regulator unit, Output filter. The Step down Transformer is used to step down the main supply voltage from 230V AC to lower value. This 230 AC voltage cannot be used directly, thus it is stepped down. The Transformer consists of primary and secondary coils. To reduce or step down the voltage, the transformer is designed to contain less number of turns in its secondary core. The output from the secondary coil is also AC waveform. Thus the conversion from AC to DC is essential. This conversion is achieved by using the Rectifier Circuit/Unit. The Rectifier circuit is used to convert the AC voltage into its corresponding DC voltage. There are Half-Wave, Full-Wave and bridge Rectifiers available for this specific function. The most important and simple device used in Rectifier circuit is the diode. The simple function of the diode is to conduct when forward biased and not to conduct in reverse bias. The Forward Bias is achieved by connecting the diode's positive with positive of the battery and negative with battery's negative. The efficient circuit used is the Full wave Bridge rectifier circuit. The output voltage of the rectifier is in rippled form, the ripples from the obtained DC voltage are removed using other circuits available. The circuit used for removing the ripples is called Filter circuit.

3.5.3 CIRCUIT(ASK Modulator):

The modulating clock signal, Vin, is fed to a transistor network working as an inverter followed by a Wein bridge oscillator. The oscillator is designed to work at a frequency of 15kHz while Vin is a 1kHz square wave. When Vin is high the transistor is on and the inverting terminal is at ground and works like ordinary Wein Bridge oscillator. When Vin is low the transistor is off and hence the net resistance at the inverting arm is R1+R2. Thegain of the oscillator reduces and hence we get an ASK modulated waveform.

For fo = 15KHz & C=0.01μF and fo=1/(2πRC); R = 1016Ω

Vin = HIGH, Af = 1+(Rf/R1); for Af = 3, Rf = 2R1; R1= 1KΩ & Rf = 2KΩ

VCC = 5V, IC = 5mA, β = 125; R2 = (VCC - VCE)/IC = 1KΩ

ASK De-Modulator: For demodulating ASK signal, we dip the ASK signal using a diode IN4007 and a capacitor to bypass the ac components, then given into an op-amp based comparator with reference voltage level at non inverting terminal, which is a dc voltage between the voltage levels of ASK modulated signal. Thus we get the ASK modulated signal at the output.

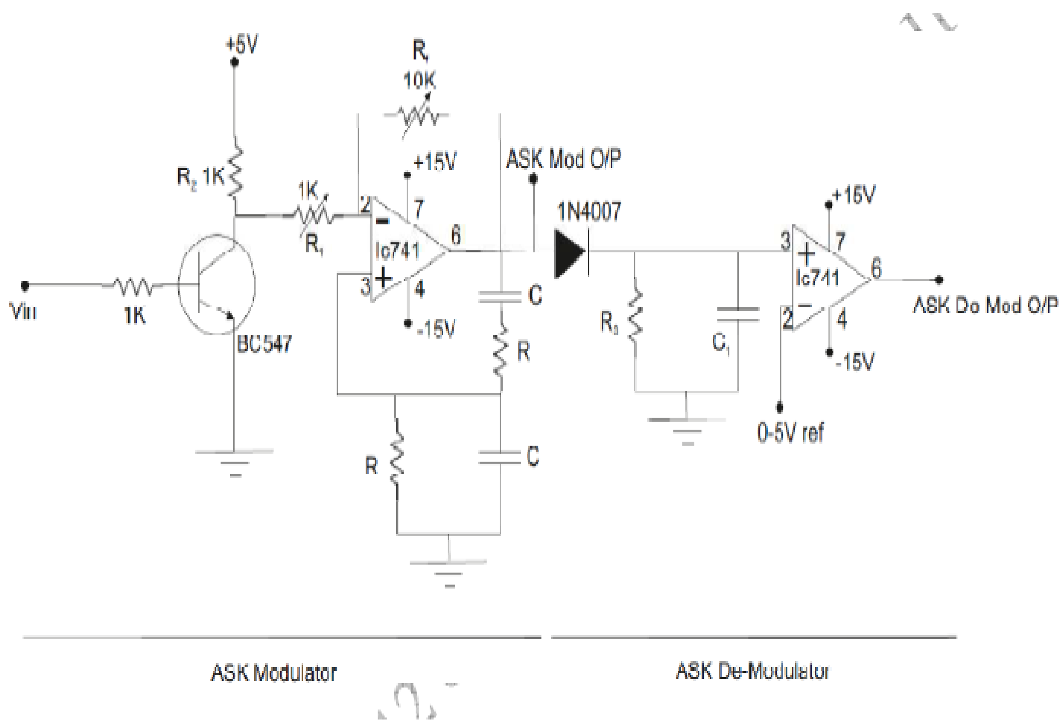


Figure 3.8 Ask modulator and ASK Demodulator

This is a remote control using HT12E and HT12D chips. HT12D & HT12E are widely used encoder/decoder chips in remote control applications made by "Holtek Semiconductors". 4 different channels can be utilized for different applications.

Sometimes in embedded design you may want to go wireless. Might be you will want to log various readings of remotely placed sensors, or simply build a remote control for robot or car alarm system.

Radio communications between two AVR microcontrollers can be easy when specialized modules are used. Lets try to run very well known RF modules TX433 and RX433 that (or similar) can be found almost in every electronics shop and pair of them cost about ~15 bucks[14].

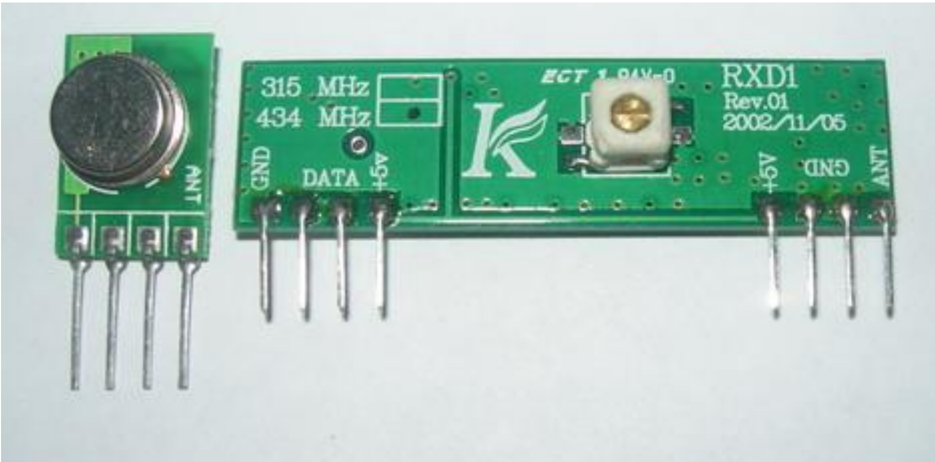


Figure 3.9 Ask transmitter and Receiver

Transmitter and receiver modules are tuned to work correctly at 433.92MHz. Transmitter can be powered from 3 to 12V power supply while receiver accepts 5V. 5V is common for AVR microcontrollers so no problems with interfacing. Modules don't require addition components – just apply power and connect single data line to send information to/from and that's it. For better distances apply 30 – 35cm antennas.

Modules use Amplitude-Shift Keying(ASK) modulation method and uses 1MHz bandwidth[14].

3.5.4Transmitter:-

The figure 3.8: given below shows schematic diagram of transmitter using IC HT12E (datasheet).

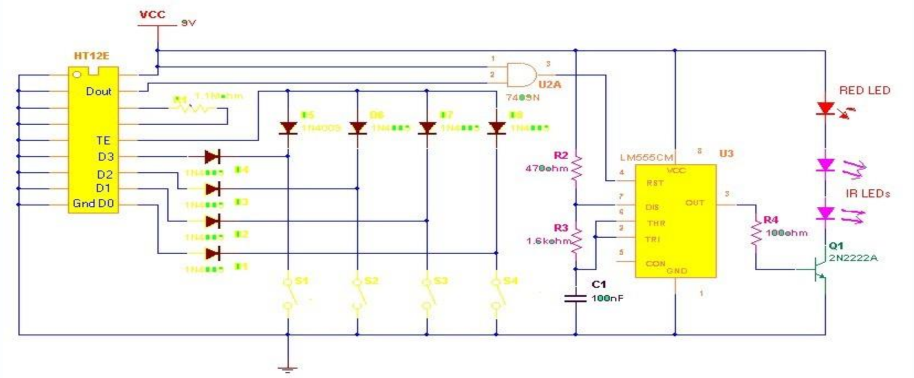


Figure 3.10: Transmitter in circuit

3.5.5 Receiver:-

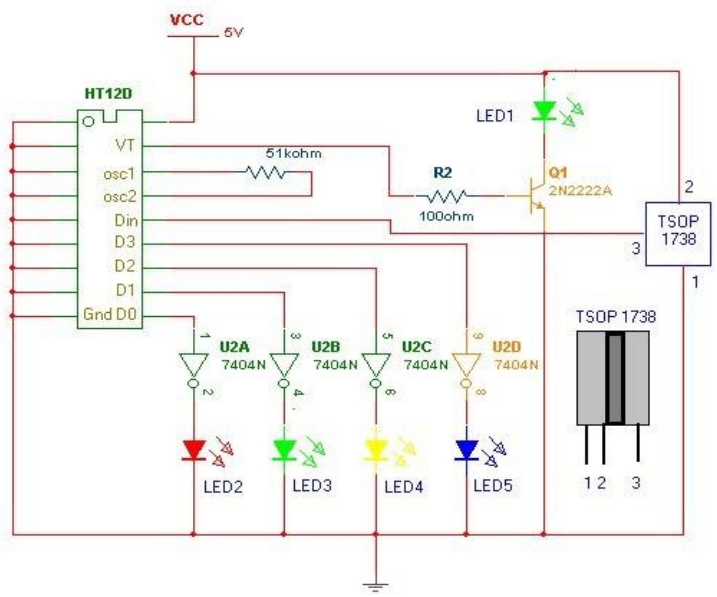


Figure 3.11: Receiver circuit using IC HT12D as shown above.

3.6 Regulators

A voltage regulator is a semiconductor device that converts an input DC voltage (usually a range of input voltages) to a fixed output DC voltage. They are used to provide a constant supply voltage within a system.

While many components in an embedded system can operate from a wide power-supply range, a fixed operating voltage is necessary for devices such as Analog-Digital Converters (ADCs), since many use the internal power supply as a reference. In other words, the output voltage of a sensor is sampled as a percentage of the voltage supply of the ADC. If the supply is not a known voltage, then any sampling performed by the ADC is meaningless Therefore, we need a voltage regulator to provide a constant voltage source, and thereby a constant voltage reference. Further, a voltage regulator can assist in removing power-supply noise and can provide a degree of protection and isolation for the embedded system from the external power supply. If your system is operating from a battery, the varying current draw of your computer can combine with the battery's internal resistance to create a varying supply voltage. The addition of a voltage regulator prevents this from becoming a problem since it provides a constant output. Including a voltage regulator in your design is good practice.

The types of regulators we will look at are termed DC-DC converters. They take an unregulated DC voltage (often over a range of possible voltages) and provide a constant DC voltage output of a fixed value.

There are three types of DC-DC converters: linear regulators, which produce lower voltages than the supply voltage; switching regulators that can step up (boost), step down (buck), or invert the input voltage; and charge pumps, which can also step up, step down, or invert the supply voltage, but with limited current-drive capability. (Note that not all charge pumps provide regulated voltage.)

The conversion process of any regulator is not 100% efficient. The regulator itself uses current (known as >quiescent current), and this is sourced from the input supply. The greater the quiescent current, the more power (and therefore heat) the regulator must dissipate. In choosing a regulator, select one that can supply the appropriate output voltage and the required current needed by your embedded system, yet has the lowest quiescent current.

Linear regulators are small, cheap, low-noise, and very easy to use. The basic circuit for a linear regulator is shown in Figure 3.6. The inputs and outputs are filtered using decoupling capacitors, but beyond that, no other external components are needed.

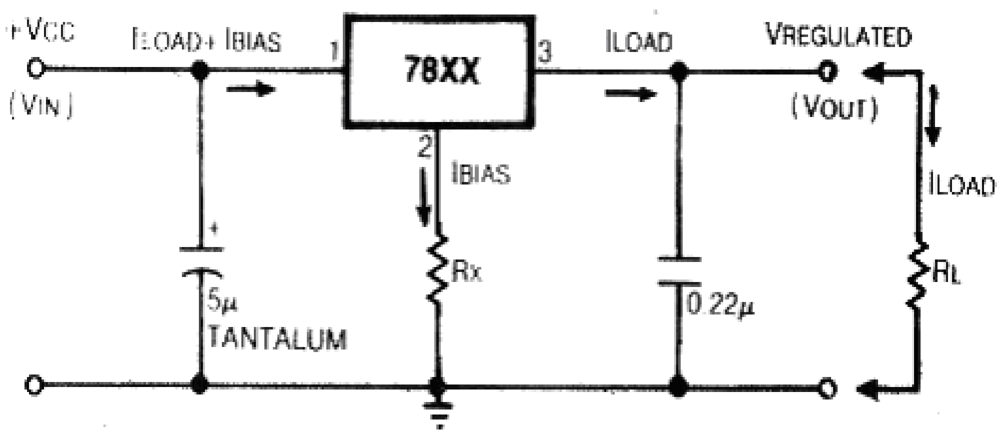


Figure 3.12 . Example of a linear regulator circuit

As well as helping to smooth the voltages, the capacitors also help remove momentary glitches in the power source known as brownouts. These momentary drops in power are infrequent, but when they occur, they can severely corrupt a computer's operation.

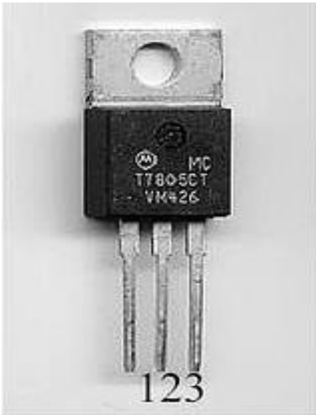


Figure 3.13 regulator

Switching regulators get their name because they switch a power transistor (MOSFET) at their output. They tend to be more efficient than linear regulators in converting the input voltage to the output voltage. In other words, they waste less power during the conversion process. However, their drawback is that they require more external components (such as an inductor and diode) and therefore take up more space. They also typically cost more and generate far more noise than linear regulators. Unlike linear regulators, they can step up a voltage as well as stepping one down, and they can also invert. For example, a switching regulator can take a supply voltage of 3.6 V from a battery and provide you with a regulated 5 V supply for your embedded system. Alternatively, a switching regulator may take an unregulated 8 V supply and convert this to a regulated -12 V supply. Switching regulators are far more versatile than linear regulators. However, they do require careful design and board layout, so pay careful attention to the directions of the particular component manufacturer. As always, read the datasheets carefully.

Charge pumps, like switching regulators, can step up, step down, or invert voltages. Unlike switching regulators, they require no external inductor. However, due to their limited capacity to supply current, they are not commonly used. The MAX3222 (and similar devices), discussed in Chapter 9, use internal charge pumps to generate the +12 V and -12 V required for RS-232C level shifting

3.7 Servo DC Motor:

Servo Motor is a DC Motor equipped with error sensing negative feedback to control the exact angular position of the shaft. Unlike DC Motors it will not rotate continuously. It is used to make angular rotations such as 0-90°, 0-180° etc. Stepper Motors can also be used for making precise angular rotations. But Servo Motors are preferred in angular motion applications like robotic arm, since controlling of servo motors are simple, needs no extra drivers like stepper motor and only angular motion is possible[20].

Operation of Hobby Servo Motor is very simple, it has only three wires, two of them (Red and Black) used to provide power and the third wire is used to provide control signals. Pulse Width Modulated (PWM) waves are used as control signals and the angular position is determined by the width of the pulse at the control input. In this tutorial we are using a servo motor having angle of rotation from 0-180° and angular position can be controlled by varying the pulse width between 1ms to 2ms.

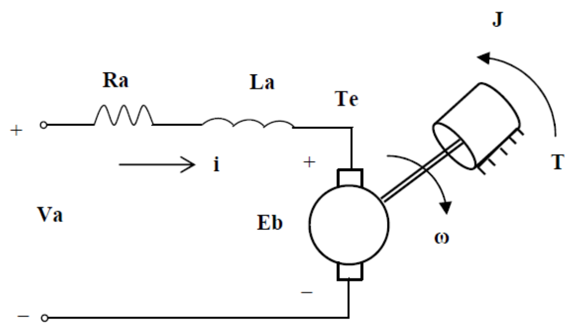


Fig.3.14: DC servo motor equivalent circuit

where, i : armature current; V_a : armature voltage; R_a :armature resistance; L_a : armature inductance; K : torque and back electromagnetic constant (Nm.A-1) rotor angular speed; $e\ T$: electromagnetic torque; T : total load torque, J : rotor inertia.

The control input is the armature voltage V_a and the total load torque T is the disturbing input. The two state variables are armature current i and angular speed [22].

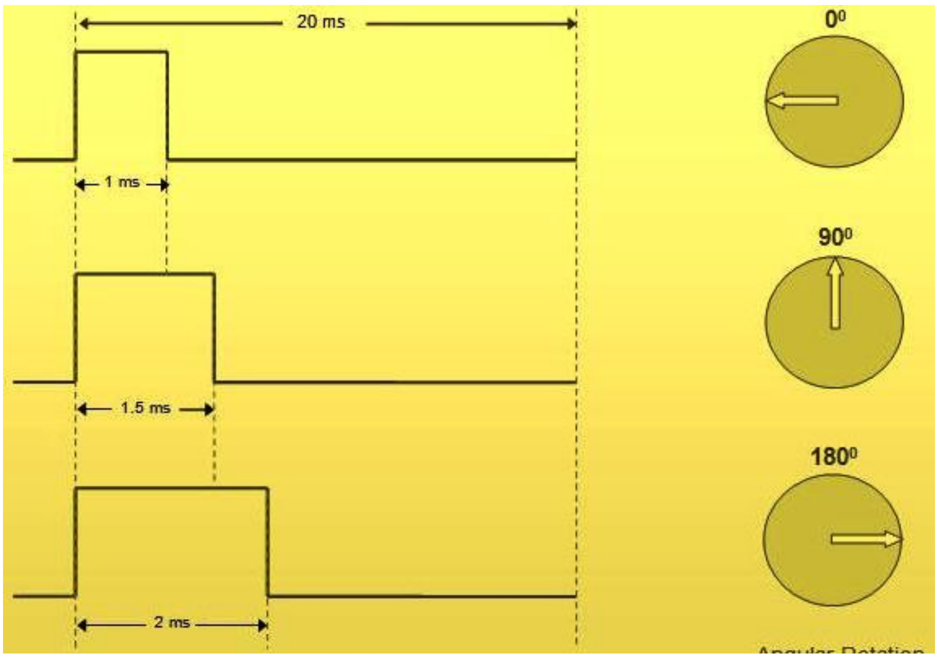


Figure 3.15: controlling angular position of Servomotor using pulse width modulation

Usually servo motors are put in plastic box, but inside there is a whole system: motor itself, gears and motor driving and control circuit.

Figure 3.16 show the servomotor

the gears reduces motor speed but increases torque. As we mentioned that servos works with closed feedback loop. This is actually potentiometer which is connected to mechanical shaft and senses the angle of turn. So potentiometer voltage directly indicate the angle of turn. Potentiometer signal goes to digital controller of motor which powers motor until potentiometer reaches desired angle, then logic shuts the motor.

Servos usually are powered by DC voltage from 4.8 to 7.2V.Usually servos are designed with limited rotation angle like 90° or 180° and so on. Of course they can be modifier for continuous rotation. Precise rotation and force thanks to gear system servos are ideal for robotic purposes[22].

Servo motor shaft is positioned with pulse width modulated signals. So all servos comes with three wires (Power, Ground and Control). So pulses are sent via control wire. Usually in hobby servos with rotation angle 90° signal width vary between 1 and 2ms. If pulse is more wide rotation continues until reaches mechanical limits.

The frequency of PWM usually is in range from 30 to 60Hz – this is so called refresh rate. If this refresh rate is too small then then accuracy of servo reduces as it starts lose its position periodically if rate is too big, then servo can start chatter. It is important to select optimal rate, that servo motor could lock its position[23].

The motor powering circuit power motor depending on what is difference between current positions and where it should be. If this difference is small the energy portion given to motors is small that it wouldn't overshoot the position – motor in this situation is driven slowly. But is difference is big, then motor is powered to turn at full speed that it could reach new position as fast as possible. When shaft approaches to new position, at the end of movement motor slows down in order to stop at accurate position. This complicated process lasts for about a half a second when rotation angle is 60°.

3.8 LCD MODULE

Selecting an LCD module involves 2 basic design decisions. 1) What size and format is required to display the desired information. 2) What optical characteristics will look best in the package and attract the user to the product. Densitron produces dot-matrix LCDs in two formats: fully functional, Alphanumeric Modules; and fully-populated Graphic modules. This set of application notes is for use with the alphanumeric (A/N) or character type modules. Refer to separate specifications and application notes for operating graphic modules.

Alpha-numeric modules display characters, numerals, symbols and some limited graphics. Interface is achieved via a bi-directional, parallel ASCII data bus. Necessary features such as Character Generation, Display RAM Addressing, Cursor Scrolling, Blanking, and Handshake are all included. User programmable fonts are supported. In summary, these modules are the simplest and most economic means to communicate meaningfully between any micro-system and the outside world. Their inclusion adds to any product's appeal.

Alpha-numeric modules range from 8 to 80 characters per line. One, two or four character lines may be chosen. Character height spans 0.130" (3.31 mm) to 0.500" (12.71 mm). Most formats are available in a variety of packages to meet various mounting requirements. Multi-line models offer the best value when analyzed by a "cost per character" basis. Displays are readable both day and night by selecting a backlight option. Extended temperature modules are available which operate between -20 and +70C. For requirements of more than 4 lines or 40 characters across, select a graphic formatted module.

Graphic modules are also used when different sized characters are needed, and when special fonts such as Chinese or Arabic are required.

Selecting the exact version of an LCD once the format is decided is largely a subjective judgment. Color, fluid type, and backlighting determine the overall look of the display and often the appearance of the end product. Operating conditions such as temperature, lighting conditions, and available power are also factors in determining the type of display to use.

The following sections explains the optical characteristic options available in A/N modules.

The fluid type determines the contrast ratio, viewing angle, and temperature range of an LCD. Desertion uses 3 basic classes of fluid, TN (Standard type), NTN (high contrast type), and STN (premium high contrast type). Many TN and NTN models are available in extended temperature range. Contact Distension for current availability[30].