Chapter 1: The Atom

1-1: Introduction:

The atom is the fundamental building block of all stuff, or what scientists like to call "matter". An individual atom is very small. In fact, the smallest type of atom, hydrogen, has a diameter of 10^{-8} cm. This means that if the hydrogen atom was the size of a soccer ball, then a soccer ball would be 6450 kilometers (4008 miles) high. Every single object is composed of atoms. Your body is made up of many, many individual atoms. There are also many different types of atoms. In fact, there are over a 100. These different types are called elements. Examples of some elements are hydrogen, oxygen, iron, copper, and helium. Under normal conditions many atoms can stick together to form larger, different stuff. Scientists call material that results from the joining of different types of atoms "compounds". An example of a compound is water, which is a group of two hydrogen atoms and one oxygen atom. Notice that we said that these types of compounds can only form under what we called "normal conditions". In the type of environment in which nuclear fusion occurs, the joining of atoms, also known as bonding can't happen.

1-2: Smaller Than the Atom:

So, are atoms made of even smaller stuff? The answer to this question is yes. Atoms are mostly empty space, but in the center of the atom is a structure called a nucleus. The nucleus is a congregation of particles. These particles are called protons and neutrons. Neutrons are neutral, or have no electrical charge. Protons, however, carry a positive electrical charge of 1. So, in a carbon atom, which has 6 protons in its nucleus, the overall electric charge of the nucleus would be 6. However, a regular atom is electrically neutral. This is because swirling around the nucleus in what is called the "electron cloud". The electrons in the electron cloud counteract the positive charges of the protons in the atomic nucleus with their negative electrical charges. This generates the neutral charge of the atom. The number of electrons and number of protons correlate in a one to one ratio. This means that there are the same number of protons and electrons in one atom. So, if an atom has 6 protons, like carbon, it will also have 6 electrons. The 6 electrons each have a charge of -1. This means that the total charge of all the electrons is -6, or -1x6. The charge of carbon's nucleus is 6 (from the protons), so when you add the two: 6 + -6, you get 0, which means that the atom, overall, has no charge.

A) Answer the following questions:

1. What is an atom?

2. What is the smallest type of atom?

3. What is the different between elements and compounds?

4. What is the electron cloud?

5. What makes an atom neutral?

B) Read each statement and decide whether it is true or false.

1. ------Hydrogen is a kind of compound.
2. ------ A regular atom is electrically neutral.
3. ------ There are not the same number of protons and electrons in one atom.
4. ------ An example of a compound is iron.
5. ------The nucleus is a structure in center of the atom.

Chapter2: What is Energy?

Energy causes things to happen around us. Look out the window. During the day, the sun gives out light and heat energy. At night, street lamps use electrical energy to light our way. Energy Is the Ability to Do Work.
Energy can be found in a number of different forms. It can be chemical energy, electrical energy, heat (thermal energy), light (radiant energy), mechanical energy, and nuclear energy.

2-1: Stored and Moving Energy

Energy makes everything happen and can be divided into two types:

I) Stored energy is called potential energy.

II) Moving energy is called kinetic energy.

With a pencil, try this example to know the two types of energy.
Put the pencil at the edge of the desk and push it off to the floor. The moving pencil uses kinetic energy.
Now, pick up the pencil and put it back on the desk. You used your own energy to lift and move the pencil. Moving it higher than the floor adds energy to it. As it rests on the desk, the pencil has potential energy. The higher it is, the further it could fall. That means the pencil has more potential energy.

2-2: How Do We Measure Energy?

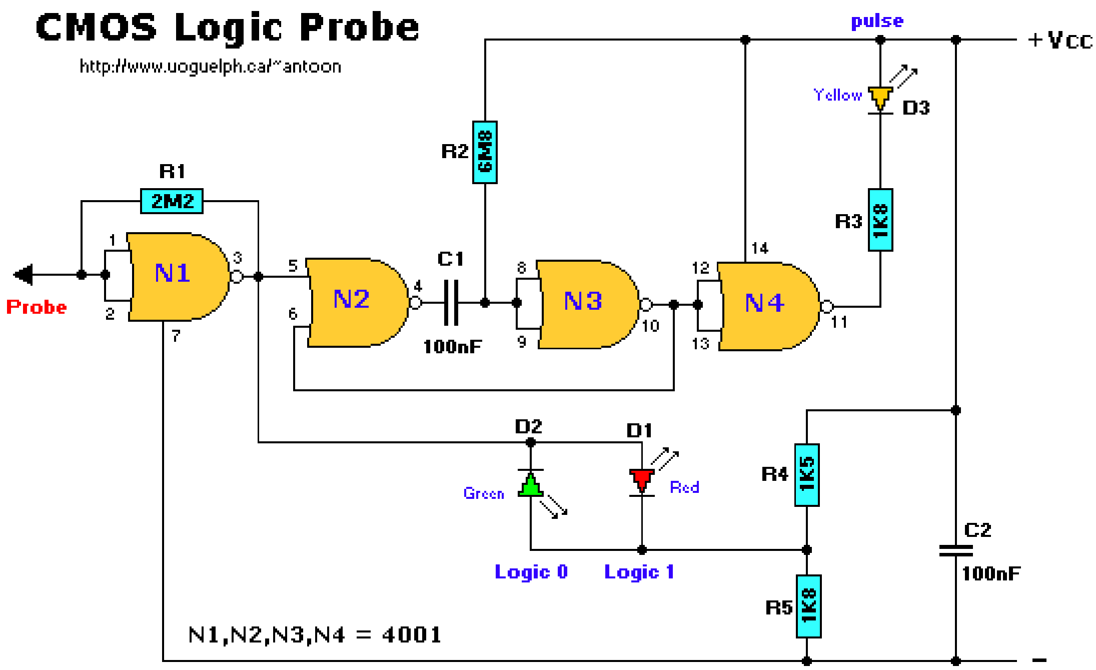
Energy is measured in many ways. One of the basic measuring blocks is called a Btu. This stands for British thermal unit and was invented by, of course, the English.
Btu is the amount of heat energy it takes to raise the temperature of one pound of water by one degree Fahrenheit, at sea level.
1,000 joules = 1 Btu
The term "joule" is named after an English scientist James Prescott Joule who lived from 1818 to 1889. He discovered that heat is a type of energy.
Around the world, scientists measure energy in joules rather than Btus. It's much like people around the world using the metric system of meters and kilograms, instead of the English system of feet and pounds.

Like in the metric system, you can have kilojoules -- "kilo" means 1,000.
1,000 joules = 1 kilojoules = 1 Btu

2-4: Changing Energy

Energy can be transformed into another sort of energy. But it cannot be created AND it cannot be destroyed. Energy has always existed in one form or another.
Here are some changes in energy from one form to another.
Stored energy in a flashlight's batteries becomes light energy when the flashlight is turned on.
Food is stored energy. It is stored as a chemical with potential energy. When your body uses that stored energy to do work, it becomes kinetic energy.
If you overeat, the energy in food is not "burned" but is stored as potential energy in fat cells.
When you talk on the phone, your voice is transformed into electrical energy, which passes over wires (or is transmitted through the air). The phone on the other end changes the electrical energy into sound energy through the speaker.
A car uses stored chemical energy in gasoline to move. The engine changes the chemical energy into heat and kinetic energy to power the car.
A television changes electrical energy into light and sound energy.

Chapter3: Logic Probe



Description:

A logic probe is a device which is used when testing digital circuits, and it shows the logic state at the selected test point. This design can indicate four input states, as follows:

1. Input high (logic 1)
2. Input low (logic 0)
3. Input pulsing (pulse)
4. Input floating

This circuit uses the four 2 did not input NOR gates contained within the 4001 CMOS IC, and is primarily intended for testing cmos circuits. The probe derives its power from the supply of the circuit being tested. The first gate, N1, has its inputs tied together so that it operates as an inverter, and it is biased by R1 so that roughly half the supply potential appears at its output. A similar voltage appears at the junction of R4 and R5, and so no significant voltage will be developed across D1 and D2 which are connected between this junction and gate 1's output pin 3. Thus under quiescent conditions, or if the probe is connected to a floating test point, neither D1 nor D2 will light up. If the input is taken to a high logic point, gate 1 output will go low and switch on D1 (red), giving a logic 'high' indication. If the input is taken to a low test point, gate 1's output pin 3 will go high and light D2 (green) to indicate a logic 'low'.

A pulsed input will contains both logic states, causing both Led's D1 and D2 to switch on alternately. However, if the duty cycle of the input signal is very high this may result in one indicator lighting up very brightly while the other does not visibly glow at all. In order to give a more reliable indication of a pulsed input, gates N2 to N4 are connected as a buffered output monostable multivibrator. The purpose of this circuit is to produce an output pulse of predetermined length (about 1/2 a second in this case) whenever it receives a positive going input pulse.

The length of the input pulse has no significant effect on the output pulse. Led D3 is connected at the output of the monostable, and is switched on for about 1/2 a second whenever the monostable is triggered, regardless of how brief the triggering input pulse happens to be. Therefore, a pulsing input will be clearly visible by the yellow Led D3 switching on.

The various outputs will be: Floating input -- all Leds off. Logic 0 input -- D2 (green) switched on (D3 briefly flashes on). Logic 1 input -- D1 switched on. Pulsing input -- D3 (yellow) switched on or pulsing in the case of a low frequency input signal

The finished project can easily be housed in a magic marker felt pen or something. The probe-tip is made of a piece of wire. Have fun building it and make it part of your trouble-shooting equipment.

Chapter4: Transistor Data Sheet

NPN general purpose transistors — BC107; BC108; BC109

FEATURES

- Low current (max. 100 mA)
- Low voltage (max. 45 V).

APPLICATIONS

- General purpose switching and amplification.

DESCRIPTION

NPN transistor in a TO-18; SOT18 metal package.
PNP complement: BC177.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	collector, connected to the case

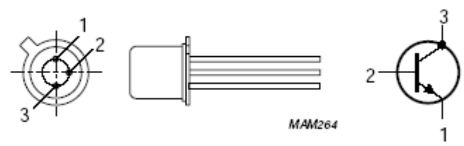


Fig.1 Simplified outline (TO-18; SOT18) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BC107		–	50	V
	BC108; BC109		–	30	V
V_{CEO}	collector-emitter voltage	open base			
	BC107		–	45	V
	BC108; BC109		–	20	V
I_{CM}	peak collector current		–	200	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	300	mW
h_{FE}	DC current gain	$I_C = 2$ mA; $V_{CE} = 5$ V			
	BC107		110	450	
	BC108		110	800	
	BC109		200	800	
f_T	transition frequency	$I_C = 10$ mA; $V_{CE} = 5$ V; f = 100 MHz	100	–	MHz

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BC107		–	50	V
	BC108; BC109		–	30	V
V_{CEO}	collector-emitter voltage	open base			
	BC107		–	45	V
	BC108; BC109		–	20	V
V_{EBO}	emitter-base voltage	open collector			
	BC107		–	6	V
	BC108; BC109		–	5	V
I_C	collector current (DC)		–	100	mA
I_{CM}	peak collector current		–	200	mA
I_{BM}	peak base current		–	200	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	300	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	junction temperature		–	175	°C
T_{amb}	operating ambient temperature		–65	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	note 1	0.5	K/mW
$R_{th\ j\text{-}c}$	thermal resistance from junction to case		0.2	K/mW

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	$I_E = 0$; $V_{CB} = 20$ V	–	–	15	nA
		$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	–	–	15	μA
I_{EBO}	emitter cut-off current	$I_C = 0$; $V_{EB} = 5$ V	–	–	50	nA
h_{FE}	DC current gain	$I_C = 10$ μA; $V_{CE} = 5$ V				
	BC107A; BC108A		–	90	–	
	BC107B; BC108B; BC109B		40	150	–	
	BC108C; BC109C		100	270	–	
h_{FE}	DC current gain	$I_C = 2$ mA; $V_{CE} = 5$ V				
	BC107A; BC108A		110	180	220	
	BC107B; BC108B; BC109B		200	290	450	
	BC108C; BC109C		420	520	800	
V_{CEsat}	collector-emitter saturation voltage	$I_C = 10$ mA; $I_B = 0.5$ mA	–	90	250	mV
		$I_C = 100$ mA; $I_B = 5$ mA	–	200	600	mV
V_{BEsat}	base-emitter saturation voltage	$I_C = 10$ mA; $I_B = 0.5$ mA; note 1	–	700	–	mV
		$I_C = 100$ mA; $I_B = 5$ mA; note 1	–	900	–	mV
V_{BE}	base-emitter voltage	$I_C = 2$ mA; $V_{CE} = 5$ V; note 2	550	620	700	mV
		$I_C = 10$ mA; $V_{CE} = 5$ V; note 2	–	–	770	mV
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 10$ V; f = 1 MHz	–	2.5	6	pF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 0.5$ V; f = 1 MHz	–	9	–	pF
f_T	transition frequency	$I_C = 10$ mA; $V_{CB} = 5$ V; f = 100 MHz	100	–	–	MHz
F	noise figure	$I_C = 200$ μA; $V_{CE} = 5$ V; $R_S = 2$ kΩ; f = 30 Hz to 15.7 kHz				
	BC109B; BC109C		–	–	4	dB
F	noise figure	$I_C = 200$ μA; $V_{CE} = 5$ V; $R_S = 2$ kΩ; f = 1 kHz; B = 200 Hz				
	BC107A; BC108A BC107B; BC108B; BC108C		–	–	10	dB
	BC109B; BC109C		–	–	4	dB

Chapter5: flip-flop

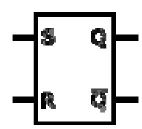
In electronics and digital circuits, the **flip-flop** or **bistable multivibrator** is a pulsed digital circuit capable of serving as a one-bit memory.

Flip-flops can be split into two main categories: level-triggered and edge-triggered. They can further be divided into four types that have found common applicability in clocked sequential systems: these are called the T ("toggle") flip-flop, the SR ("set-reset") flip-flop, the JK flip-flop, and the D ("data") flip-flop. The behavior of the flip-flop is described by what is termed the characteristic equation, which derives the "next" (i.e., after the next clock pulse) output, Q_{next}, in terms of the input signal(s) and/or the current output, Q.

The first electronic flip-flop was invented in 1919 by William Eccles and F. W. Jordan .

Set-reset flip-flops (SR flip-flops)

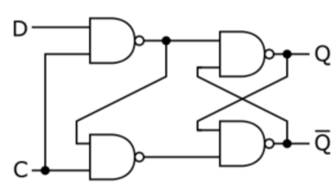
The SR (set-reset) flip-flop has two inputs: S (set) and R (reset). If R is active, The output goes to zero. If S is active, the output goes to one. If neither is activated, the previous state is maintained. Both inputs should not be activated simultaneously; however, if they are, the typical response is for both the inverted and non inverted outputs to have the same level.



We can implement SR flip-flop with a pair of either NAND or NOR gates. The NOR version is conceptually easier as it has active high inputs. However, the NAND version is more widely known and used, as NAND gates were cheaper in transistor-transistor logic.

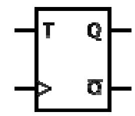
D-type transparent latch

If we add two NAND gates to an unclocked SR flip-flop as in the following diagram, we get a "D-type transparent latch". When enable is active, the output follows the input, when enable is low; the output is latched at what it was when enable was last high.



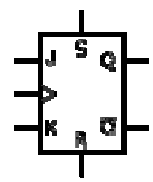
Edge-triggered flip-flops

Edge-triggered flip-flops only change state on a particular edge (rising, falling, or very occasionally both directions) of a designated clock signal.



If the T input is high, the T flip-flop changes state ("toggles") whenever the clock input is strobed. If the T input is low, the flip-flop holds the previous value.

JK flip-flop



The JK flip-flop augments the behavior of the SR flip-flop by interpreting the S = R = 1 condition as a "flip" command. Specifically, the combination J = 1, K = 0 is a command to set the flip-flop; the combination J = 0, K = 1 is a command to reset the flip-flop; and the combination J = K = 1 is a command to toggle the flip-flop, i.e., change its output to the logical complement of its current value. Setting J = K = 0 results in a D-type flip-flop. The JK flip-flop is therefore a universal flip-flop, because it can be configured to work as an SR flip-flop, a D flip-flop or a T flip-flop.

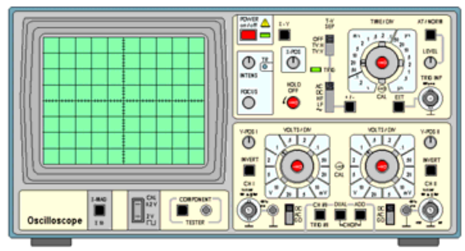
The origin of the name for the JK flip-flop is detailed by P. L. Lindley, a JPL engineer, in a letter to EDN, an electronics newsletter. The letter is dated June 13, 1968, and was published in the August edition of the newsletter. In the letter, Mr. Lindley explains that he heard the story of the JK flip-flop from Dr. Eldred Nelson, who is responsible for coining the term while working at Hughes Aircraft.

Flip-flops in use at Hughes at the time were all of the type that came to be known as J-K. In designing a logical system, Dr. Nelson assigned letters to flip-flop inputs as follows: #1: A & B, #2: C & D, #3: E & F, #4: G & H, #5: J & K. Given the size of the system that he was working on, Dr. Nelson realized that he was going to run out of letters, so he decided to use J and K as the set and reset input of each flip-flop in his system (using subscripts or some such to distinguish the flip-flops), since J and K were "nice, innocuous letters."

Dr. Montgomery Phister, Jr., an engineer under Dr. Nelson at Hughes, picked up the idea that J and K were the set and reset input for a "Hughes type" of flip-flop, which he then termed "J-K flip-flops," a name that he carried with him when he left for Scientific Data Systems in Santa Monica.

Chapter6: What does an oscilloscope do?

An oscilloscope is easily the most useful instrument available for testing circuits because it allows you to *see* the signals at different points in the circuit. The best way of investigating an electronic system is to monitor signals at the input and output of each system block, checking that each block is operating as expected and is correctly linked to the next. With a little practice, you will be able to find and correct faults quickly and accurately.



An oscilloscope is an impressive piece of kit:

The diagram shows a *Hameg HM 203-6* oscilloscope.

Faced with an instrument like this, students typically respond either by twiddling every knob and pressing every button in sight, or by adopting a glazed expression. Neither approach is especially helpful. Following the systematic description below will give you a clear idea of what an oscilloscope is and what it can do.

The function of an oscilloscope is extremely simple: it draws a *V/t* graph, a graph of voltage against time, voltage on the vertical or Y-axis, and time on the horizontal or X-axis.

'Dual trace' oscilloscopes display two *V/t* graphs at the same time, so that simultaneous signals from different parts of an electronic system can be compared.

Setting up

1. Someone else may have been twiddling knobs and pressing buttons before you. Before you switch the oscilloscope on, check that all the controls are in their 'normal' positions. For the *Hameg HM 203-6*, this means that:

All push button switches are in the OUT position

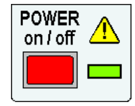
All slide switches are in the UP position

All rotating controls are CENTRED

The central TIME/DIV and VOLTS/DIV and the HOLD OFF controls are in the calibrated, or CAL position

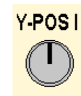
2. Set both VOLTS/DIV controls to 1 V/DIV and the TIME/DIV control to 2 s/DIV, its slowest setting:

3. Switch ON, red button, top centre:



The green LED illuminates and, after a few moments, you should see a small bright spot, or **trace**, moving fairly slowly across the screen.

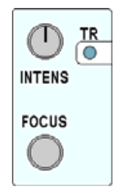
4. Find the Y-POS 1 control:



The Y-POS 1 allows you to move the spot up and down the screen. For the present, adjust the trace so that it runs horizontally across the centre of the screen.

5. Now investigate the INTENSITY and FOCUS controls:

When these are correctly set, the spot will be reasonably bright but not glaring, and as sharply focused as possible. (The TR control is screwdriver adjusted. It is only needed if the spot moves at an angle rather than horizontally across the screen with no signal connected.)



6. The TIME/DIV control determines the horizontal scale of the graph which appears on the oscilloscope screen.

Now rotate the TIME/DIV control clockwise, With each new setting, the spot moves faster. At around 10 ms/DIV, the spot is no longer separately visible. Instead, there is a bright line across the screen. This happens because the screen remains bright for a short time after the spot has passed an effect which is known as the **persistence** of the screen. It is useful to think of the spot as still there, just moving too fast to be seen.

7. The VOLTS/DIV controls determine the vertical scale of the graph drawn on the oscilloscope screen.

The *Hameg HM 203-6* has a built in source of signals which allow you to check that the oscilloscope is working properly. A connection to the input of channel 1, CH 1, of the oscilloscope can be made using a special connector called a BNC plug, The diagram shows a lead with a BNC plug at one end and crocodile clips at the other. When the crocodile clip from the red wire is clipped to the lower metal terminal, a 2 V square wave is connected to the input of CH 1.

Chapter7: What is PSPICE?

SPICE is a powerful general purpose analog and mixed-mode circuit simulator that is used to verify circuit designs and to predict the circuit behavior. Which was developed at the University of California at Berkeley. PSPICE is one of the many commercial SPICE derivatives, and has been developed by MicroSim Corporation.

SPICE stands for Simulation Program with Integrated Circuit Emphasis.

How does PSPICE help in circuit design?

SPICE can do several *types of circuit analyses*. Here are the most important ones:

• Non-linear DC analysis: calculates the DC transfer curve.
• Non-linear transient and Fourier analysis
• Linear AC Analysis
• Noise analysis
• Parametric analysis
• Monte Carlo Analysis

In addition, PSPICE has analog and digital libraries of standard components (such as NAND, NOR, flip-flops, MUXes, FPGA, PLDs and many more digital components).This makes it a useful tool for a wide range of analog and digital applications.

The circuit can contain the following components:

• Independent and dependent voltage and current sources
• Resistors, Capacitors, Inductors, Mutual inductors
• Transmission lines
• Operational amplifiers
• Switches
• Diodes, Bipolar transistors, MOS transistors, JFET, MESFET,
• Digital gates
• And other components

Chapter8: What is a PLC?

A programmable logic controller, also called a *PLC* or *programmable controller*, is a computer-type device used to control equipment in an industrial facility. The kinds of equipment that PLCs can control are as varied as industrial facilities themselves. Conveyor systems, food processing machinery, auto assembly lines, In a traditional industrial control system, all control devices are wired directly to each other according to how the system is supposed to operate. In a PLC system, however, the PLC replaces the wiring between the devices. Thus, instead of being wired directly to each other, all equipment is wired to the PLC. Then, the control program inside the PLC provides the “wiring” connection between the devices.

The control program is the computer program stored in the PLC’s memory that tells the PLC what’s supposed to be going on in the system. The use of a PLC to provide the wiring connections between system devices is called *softwiring*.

Why use PLCS?

The softwiring advantage provided by programmable controllers is tremendous. In fact, it is one of the most important features of PLCs. Softwiring makes changes in the control system easy and cheap. If you want a device in a PLC system to behave differently or to control a different process element, all you have to do is change the control program. In a traditional system, making this type of change would involve physically changing the wiring between the devices, a costly and time-consuming endeavor.

In addition to the programming flexibility we just mentioned, PLCs offer other advantages over traditional control systems. These advantages include:

• High reliability

• Small space requirements

• computing capabilities

• reduced costs

• Ability to withstand harsh environments

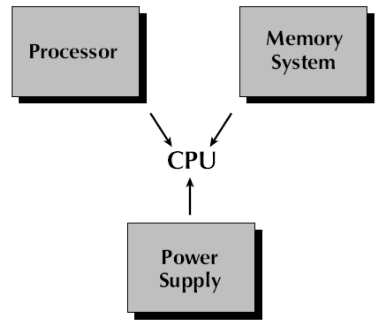
• Expandability

But what exactly is a PLC?

A PLC basically consists of two elements:

• The central processing unit

• The input/output system



The Central Processing Unit

The central processing unit (CPU) is the part of a programmable controller that retrieves, decodes, stores, and processes information.

The CPU has three parts:

• The processor

• The memory system

• The power supply

The processor is the section of the CPU that codes, decodes, and computes data. The memory system is the section of the CPU that stores both the control program and data from the equipment connected to the PLC. The power supply is the section that provides the PLC with the voltage and current it needs to operate.

The Input/output System

The input/output (I/O) system is the section of a PLC to which all of the field devices are connected. If the CPU can be thought of as the brains of a PLC, then the I/O system can be thought of as the arms and legs. The I/O system is what actually physically carries out the control commands from the program stored in the PLC's memory.

The I/O system consists of two main parts:

• The rack

• I/O modules

The rack is an enclosure with slots in it that is connected to the CPU. I/O modules are devices with connection terminals to which the field devices are wired. Together, the rack and the I/O modules form the interface between the field devices and the PLC.

Chapter9: ATmega8 Summary

Features

8-bit AVR® with 8K Bytes In-System Programmable Flash

• High-performance, Low-power AVR® 8-bit Microcontroller

• Advanced RISC Architecture

– 130 Powerful Instructions – Most Single-clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– Fully Static Operation

– Up to 16 MIPS Throughput at 16 MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory segments

– 8K Bytes of In-System Self-programmable Flash program memory

– 512 Bytes EEPROM

– 1K Byte Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

– Data retention: 20 years at 85°C/100 years at 25°C

–In-System Programming by on-chip Boot Program, True Read-While-Write Operation

– Programming Lock for Software Security

• Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode

– One16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode

– Real Time Counter with Separate Oscillator

– Three PWM Channels

– 8-channel ADC in TQFP and QFN/MLF package. Eight Channels 10-bit Accuracy

– 6-channel ADC in PDIP package, Six Channels 10-bit Accuracy

– Byte-oriented Two-wire Serial Interface

– Programmable Serial USART

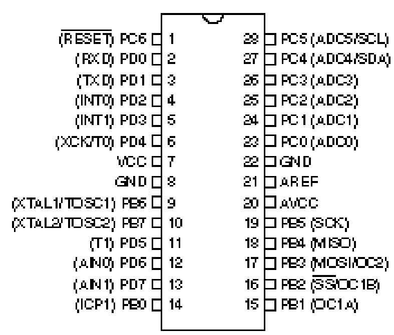
– Master/Slave SPI Serial Interface

– Programmable Watchdog Timer with Separate On-chip Oscillator

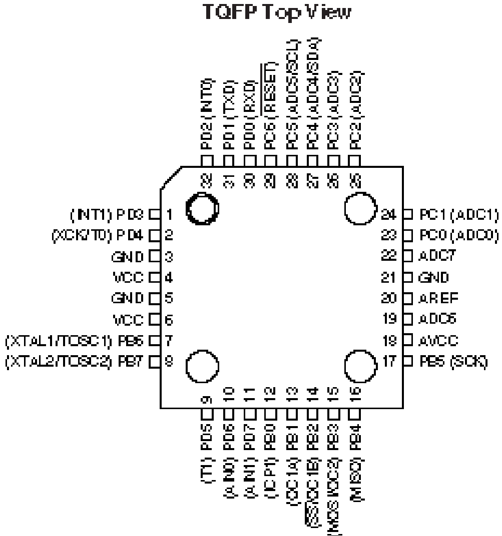
– On-chip Analog Comparator

- Special Microcontroller Features
– Power-on Reset and Programmable Brown-out Detection
– Internal Calibrated RC Oscillator
– External and Internal Interrupt Sources
– Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby
- I/O and Packages
– 23 Programmable I/O Lines
– 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF
- Operating Voltages [– 2.7 - 5.5V (ATmega8L)], [– 4.5 - 5.5V (ATmega8)]
- Speed Grades [– 0 - 8 MHz (ATmega8L)], [– 0 - 16 MHz (ATmega8)]
- Power Consumption at 4 MHz, 3V, 25°C
– Active: 3.6 mA
– Idle Mode: 1.0 mA
– Power-down Mode: 0.5 µA

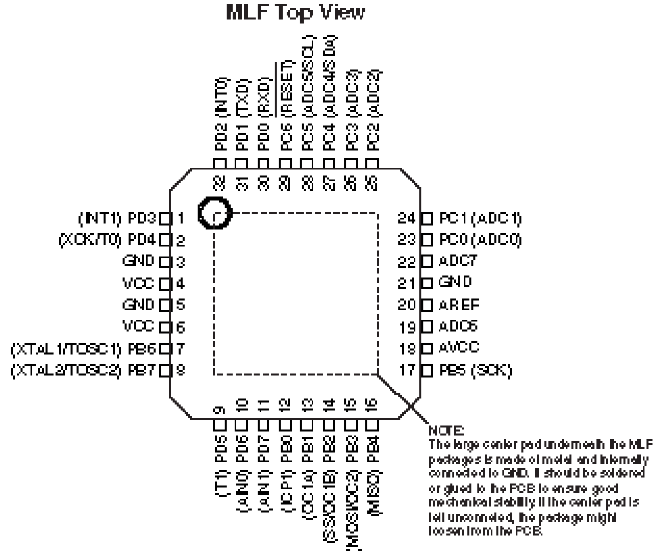
PDIP



TQFP Top View



MLF Top View



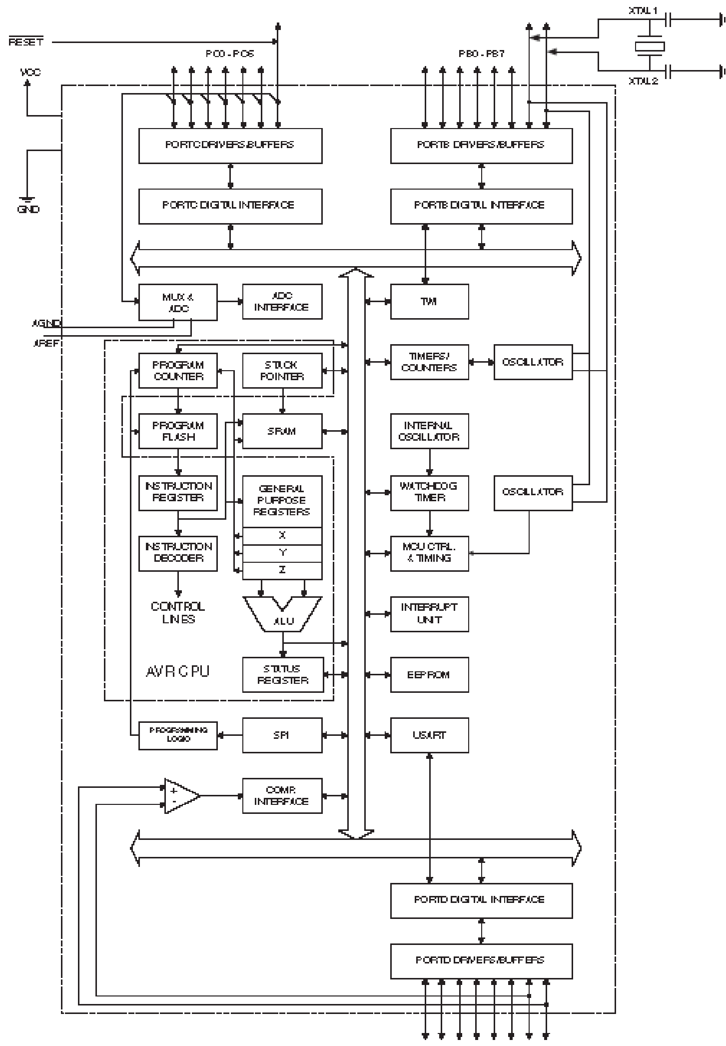
Overview

The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture.

By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. 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 ATmega8 AVR 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.



Chapter10: SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY GREEN MAN4400A SERIES
ORANGE MAN4600A SERIES
RED MAN4700A SERIES

The MAN4400, MAN4600, MAN4700 and MAN4800 Series provide superior brightness in a choice of color LED displays. Standard units are available in Red, Green, and Orange. They can be mounted in arrays with 0.400 inch (10.16 mm) center-to-center spacing. The Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

Features:

• Common anode or common cathode models
• Red, Green and Orange
• Fast switching-excellent for multiplexing
• Low power consumption
• Bold solid segments that are highly legible
• Solid state reliability-long operation life
• Impact resistant plastic construction
• Directly compatible with integrated circuits
• High brightness with high contrast
• Categorized for Luminous Intensity (See Note 6)
• Standard 14 pin dual-in-line package configuration
• Wide angle viewing ... 150’
• Package size and lead configuration is the same as MAN50, N3600, N70, N80A Series

Applications:

For industrial and consumer applications such as:

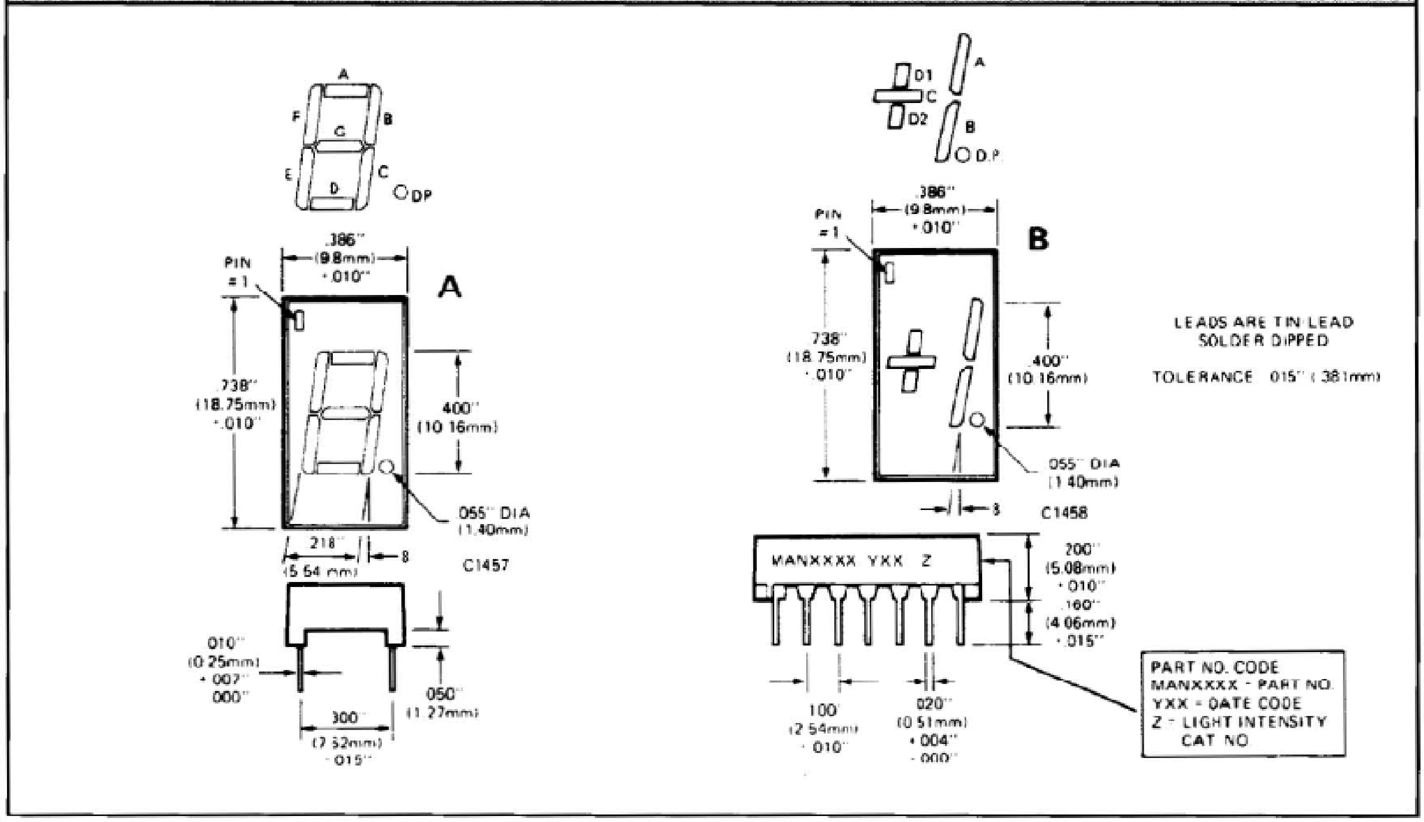
• Digital readout displays
• Instrument panels
• Point of sale equipment
• Calculators

- Digital clocks
- High ambient light conditions

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN4410A	Green	Common Anode; Right Hand Decimal	A	A
MAN4440A	Green	Common Cathode; Right Hand Decimal	A	C
MAN4610A	Orange	Common Anode; Right Hand Decimal	A	A
MAN4630A	Orange	Common Anode; Overflow ±1; Right Hand Decimal	B	B
MAN4640A	Orange	Common Cathode; Right Hand Decimal	A	C
MAN4705A	Red	Universal (CA or CC) Overflow ±1; Right Hand Decimal	B	D
MAN4710A	Red	Common Anode; Right Hand Decimal	A	A
MAN4740A	Red	Common Cathode; Right Hand Decimal	A	C

PACKAGE DIMENSIONS



Chapter11: Timer NE/SA/SE555/SE555C

DESCRIPTION

The 555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA.

FEATURES

- Turn-off time less than 2 ms
- Max. Operating frequency greater than 500 kHz
- Timing from microseconds to hours
- Operates in both astable and monostable modes
- High output current
- Adjustable duty cycle
- TTL compatible
- Temperature stability of 0.005% per °C

APPLICATIONS

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation

PIN CONFIGURATION

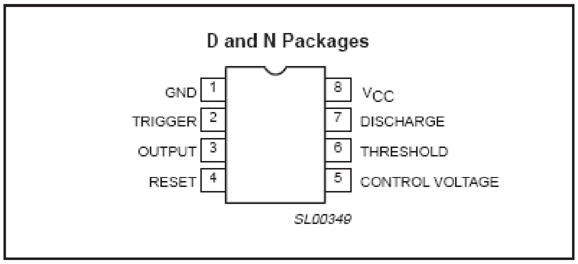


Figure 1. Pin configuration

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline (SO) Package	0 to +70 °C	NE555D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70 °C	NE555N	SOT97-1
8-Pin Plastic Small Outline (SO) Package	–40 °C to +85 °C	SA555D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +85 °C	SA555N	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	–55 °C to +125 °C	SE555CN	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	–55 °C to +125 °C	SE555N	SOT97-1

DC AND AC ELECTRICAL CHARACTERISTICS

T_{amb} = 25 °C, V_{CC} = +5 V to +15 V unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE555			NE555/SA555/SE555C			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{CC}	Supply voltage		4.5		18	4.5		16	V
I_{CC}	Supply current (low state)[1]	V_{CC} = 5 V, $R_L = \infty$ V_{CC} = 15 V, $R_L = \infty$		3 10	5 12		3 10	6 15	mA mA
 t_M $\Delta t_M/\Delta T$ $\Delta t_M/\Delta V_S$	Timing error (monostable) Initial accuracy[2] Drift with temperature Drift with supply voltage	R_A = 2 kΩ to 100 kΩ C=0.1 µF		 0.5 30 0.05	 2.0 100 0.2		 1.0 50 0.1	 3.0 150 0.5	 % ppm/°C %/V
 t_A $\Delta t_A/\Delta T$ $\Delta t_A/\Delta V_S$	Timing error (astable) Initial accuracy[2] Drift with temperature Drift with supply voltage	R_A, R_B = 1 kΩ to 100 kΩ C = 0.1 µF V_{CC} = 15 V		 4 0.15	 6 500 0.6		 5 0.3	 13 500 1	 % ppm/°C %/V
V_C	Control voltage level	V_{CC} = 15 V V_{CC} = 5 V	9.6 2.9	10.0 3.33	10.4 3.8	9.0 2.6	10.0 3.33	11.0 4.0	V V
V_{TH}	Threshold voltage	V_{CC} = 15 V V_{CC} = 5 V	9.4 2.7	10.0 3.33	10.6 4.0	8.8 2.4	10.0 3.33	11.2 4.2	V V
I_{TH}	Threshold current[3]			0.1	0.25		0.1	0.25	µA
V_{TRIG}	Trigger voltage	V_{CC} = 15 V V_{CC} = 5 V	4.8 1.45	5.0 1.67	5.2 1.9	4.5 1.1	5.0 1.67	5.6 2.2	V V
I_{TRIG}	Trigger current	V_{TRIG} = 0 V		0.5	0.9		0.5	2.0	µA
V_{RESET}	Reset voltage[4]	V_{CC} = 15 V, V_{TH} = 10.5 V	0.3		1.0	0.3		1.0	V
I_{RESET}	Reset current Reset current	V_{RESET} = 0.4 V V_{RESET} = 0 V		0.1 0.4	0.4 1.0		0.1 0.4	0.4 1.5	mA mA
V_{OL}	LOW-level output voltage	V_{CC} = 15 V I_{SINK} = 10 mA I_{SINK} = 50 mA I_{SINK} = 100 mA I_{SINK} = 200 mA		 0.1 0.4 2.0 2.5	 0.15 0.5 2.2		 0.1 0.4 2.0 2.5	 0.25 0.75 2.5	 V V V V
		V_{CC} = 5 V I_{SINK} = 8 mA I_{SINK} = 5 mA		 0.1 0.05	 0.25 0.2		 0.3 0.25	 0.4 0.35	 V V
V_{OH}	HIGH-level output voltage	V_{CC} = 15 V I_{SOURCE} = 200 mA I_{SOURCE} = 100 mA	 13.0	 12.5 13.3		 12.75	 12.5 13.3		 V V
		V_{CC} = 5 V I_{SOURCE} = 100 mA	 3.0	 3.3		 2.75	 3.3		 V
t_{OFF}	Turn-off time[5]	$V_{RESET} = V_{CC}$		0.5	2.0		0.5	2.0	µs
t_R	Rise time of output			100	200		100	300	ns
t_F	Fall time of output			100	200		100	300	ns
	Discharge leakage current			20	100		20	100	nA

NOTES:

1. Supply current when output high typically 1 mA less.

2. Tested at VCC = 5 V and VCC = 15 V.

3. This will determine the max value of RA+RB, for 15 V operation, the max total R = 10 MW, and for 5 V operation, the max. Total R = 3.4 MW.

4. Specified with trigger input HIGH.

5. Time measured from a positive-going input pulse from 0 to 0.8×VCC into the threshold to the drop from HIGH to LOW of the output. Trigger is tied to threshold.

Chapter12: OPerational AMPlifier

An operational amplifier IC is a solid-state integrated circuit that uses external feedback to control its functions. The term 'op-amp' was originally used to describe a chain of high performance dc amplifiers that was used as a basis for the analog type computers of long ago. The very high gain op-amp IC's our days uses external feedback networks to control responses. The op-amp without any external devices is called 'open-loop' mode, referring actually to the so-called 'ideal' operational amplifier with infinite open-loop gain, input resistance, bandwidth and a zero output resistance. However, in practice no op-amp can meet these ideal characteristics.
Today the types of op amps have increased almost daily. We now enjoy a variety of op amps that will provide the user essentially with anything s/he needs, such as high common-mode rejection, low-input current frequency compensation, cmos, and short-circuit protection. All a designer has to do is expressing his needs and is then supplied with the correct type. Op-Amps are continually being improved, especially in the low-noise areas.

Logic Symbol

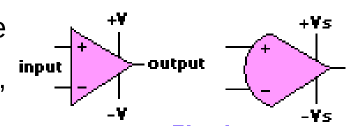


Fig. 1

Shown in Fig.1 at the right are op-amp symbols as used today.

Absolute Maximum Parameters:

Maximum means that the op-amp can safely tolerate the maximum ratings as given in the data section of such op-amp without the possibility of destroying it. The uA741 is a high performance operational amplifier with high open loop gain, internal compensation, high common mode range and exceptional temperature stability. The uA741 is short-circuit protected and allows for nulling of the offset voltage. The uA741 is manufactured by Fairchild Semiconductor.

Max Ratings	Fig. 2
Supply voltage	±18Volts
Internal Power Dissipation	500mW
Differential Input Voltage	±30Volt
Input voltage	±15Volt
Voltage Offset Null/V-	±0.5Volt
Operating Temperature Range	0°to +70°C
Storage Temperature Range	-65°to +150°C
Lead Temperature, Solder, 60sec.	300°C
Output Short Circuit	Indefinite

Supply Voltage (+/-Vs): The maximum voltage (positive and negative) that can be safely used to feed the op-amp.

Dissipation (P_d): The maximum power the op-amp is able to dissipate, by specified ambient temperature (500mW @ 80° C).

Differential Input Voltage (V_{id}): This is the maximum voltage that can be applied across the + and - inputs.

Input Voltage (V_{icm}): The maximum input voltage that can be simultaneously applied between both input and ground also referred to as the common-mode voltage. In general, the maximum voltage is equal to the supply voltage.

Operating Temperature (T_a): This is the ambient temperature range for which the op-amp will operate within the manufacturer's specifications. Note that the military grade version (uA741) has a wider temperature range than the commercial, version (uA741C).

Output Short-Circuit Duration: This is the amount of time that an op-amp's output can be short-circuited to either supply voltage.

Input Parameters:

Input Offset Voltage (V_{oi})

This is the voltage that must be applied to one of the input pins to give a zero output voltage. Remember, for an ideal op-amp, output offset voltage is zero!

Input Bias Current (I_b)

This is the average of the currents flowing into both inputs. Ideally, the two input bias currents are equal.

Input Offset Current (I_{os})

This is the difference of the two input bias currents when the output voltage is zero.

Input Voltage Range (V_{cm})

The range of the common-mode input voltage (i.e. the voltage common to both inputs and ground).

Input Resistance (Z_i)

The resistance 'looking-in' at either input with the remaining input grounded.

Chapter13: exercises

A)language practice :

1) An antenna is a device that ……………………….electromagnetic energy into space.

a)converts b)generates c)receives d)radiates

2)With the……………………….circuit; the transistor's base lead is common to both the input and output signal.

a)common-base b)common-collector c)common-source d)common-emitter

3) The region from which charge carriers are injected into the base is known as the……………

a) emitter b) collector c) donor d) injector

4) As a matter of fact, the name ………………..was derived from the fact , that through base control we can 'transfer' different values of 'resistance' between the emitter and collector.

a)thermistor b)transformer c)transistor d)transmitter

5) In …………………modulation, the amplitude of the carrier wave is kept constant, but the frequency is varied in proportion to the amplitude of the modulation signal.

a)amplitude b)phase c)frequency d)all of the above

6) Integrated circuits offer many advantages over ……………..component circuit in size, performance and reliability

a)distributed b)discrete c)analogue d)digital

7) A microphone …………………the acoustical energy in an input sound wave into the electrical energy of an output current.

a)normalize b)rectifies c)reverse d)converts

8) A bit is ………………..

a)decimal digit b)binary digit

c) smallest unit of information d) part 2 and 3

B) Fill in the blanks

Field	Current	Electrical	Resistance
Attraction	Properties	Magnet	Electrons

1) If there is a potential difference between the ends of a conductor, a ……………….will flow along it.

2) The magnetic ……………….increase with an increase in the current.

3) Generators are machines used for the large-scale production of……………energy.

4) Resistors are devices whereby ……….is interposed in a circuit.

C) Match the words

Column (I)	Column (II)
1)electromagnetism	a)work got out of a machine divided by the work put in
2)efficiency	b)cause to exit or occur; produce
3)magnetization	c)science of the relations between magnetism and electric current
4)loop	d)process of turning a piece of magnetic material into a magnet
5)electrify	e)charge something with electricity
6)generate	f)moving
7)kinetic	g)simple closed connection