AS Systems & Control Study Notes

Part 1: Systems & Symbols

Part 1 Learning Objectives

- Understand how systems can be broken down in to: Inputs, Outputs and Processes.
- Be able to identify components and systems as: Inputs, Outputs and Processes.
- Be able to identify electronic components by physical appearance and their BSI symbolic representation.

System building blocks

All systems can be broken up into discrete building blocks:

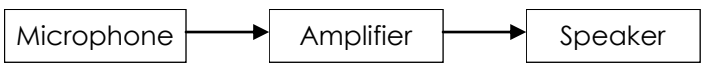
Inputs
Processes
Outputs

Input components are those which take in some form of signal or energy and convert it in to an electrical signal.

Output components are those which take an electrical signal and convert it into another form of energy such as light, heat and sound.

A process takes in signals from the input, processes it in some way, and presents it to the output.

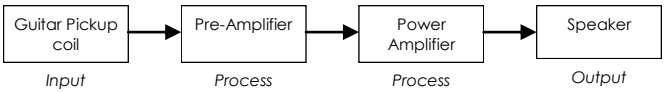
Some basic system diagrams are shown



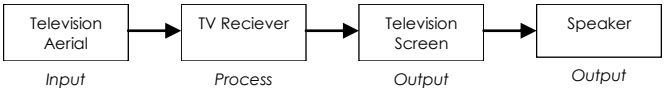
More complex systems

Most real systems contain more than one input, output and process. Below are some simplified system diagrams of such systems:

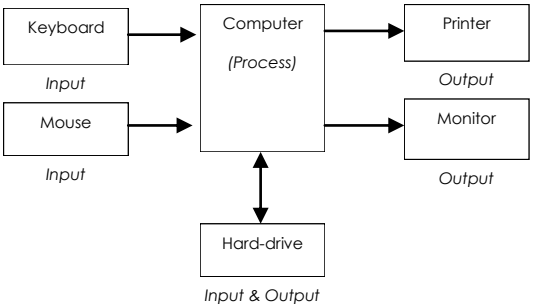
Electric Guitar amplifier



Television Reciever



Personal Computer



Closed-loop and Open-loop systems

The system diagrams above show examples of *open-loop* systems. Open-loop systems take in inputs, process them and send them to the output.

Closed-loop systems however have what is known as *feedback*. This means that a system can monitor the output device and adjust the properties of the process. In reality most systems contain some form of feedback. Examples of closed-loop systems are shown on the following page:

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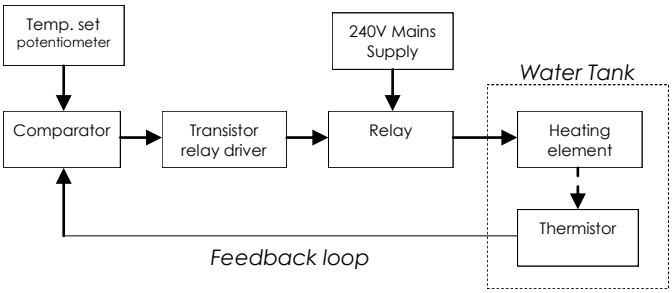
A practical closed-loop system
Hot water heater

The system diagram below shows an example of a simple closed-loop system. The system shows how a tank of water can be kept at a constant temperature:



Elements of the system

Firstly it must be noted that both the heating element and the thermistor are mounted within the water tank.

Before the operation of the system is discussed the function of the individual elements will be described:

Heating Element: Heats up the water when current flows through it.

Potentiometer: A potentiometer is a type of variable resistor (like the volume control on a stereo.) It produces a voltage dependent on the position of the control knob. In this case it is used to set the desired temperature.

Comparator: A comparator is a circuit with two inputs. The circuit compares the voltages on its two inputs and produces an output when the voltage on one input is higher than the other.

Relay: A relay is an electromechanical switch. It allows large voltages and currents to be switched by a small voltage and current.

Operation of the system

The temperature control knob (potentiometer) is adjusted to set the desired temperature to, say, 60C.

The thermistor presents the comparator with a voltage relative to the temperature of the water tank (this is the feedback loop).

Initially the water temperature will be cold.

The comparator compares the two voltages provided by the potentiometer and the thermistor. Initially the thermistor will provide a lower voltage than the "temperature set" potentiometer because the tank is cold. In this situation the output of the comparator will turn on. This in turn activates the relay which will then switch on the power to the heating element causing the water to gradually heat up.

The tank will continue to heat up to around 60C. A point will be reached however when the water temperature is a little over 60C.

The voltage provided from the thermistor will now be higher than the one from the potentiometer. The comparator will compare these two input voltages, detect that that the water is too warm and will switch off the relay. The power to the heating element will therefore be interrupted. The tank will start to cool down.

Once the temperature of the water drops to just below 60C the heating element will be switched back on again.

This process continues indefinitely; the feedback from the thermistor being used to maintain the temperature of the water at 60C by turning the heating element on and off as desired.

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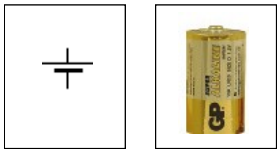
AS Systems & Control Study Notes

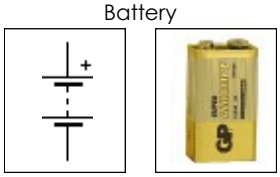
Part 1: Systems & Symbols

Power Supplies

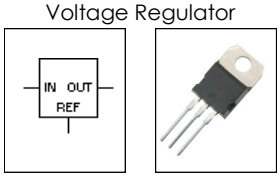
Cell



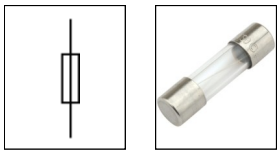
Battery



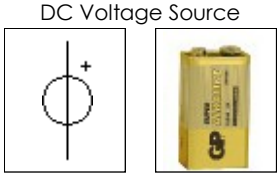
Voltage Regulator



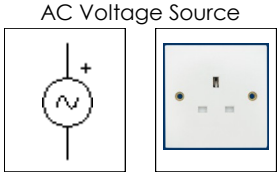
Fuse



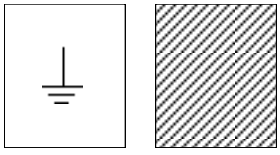
DC Voltage Source



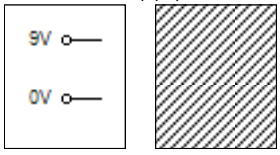
AC Voltage Source



Earth Connection

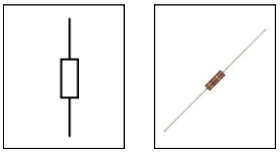


Power Supply Rails

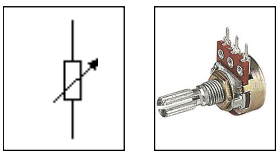


Passive Components

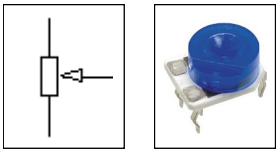
Fixed Resistor



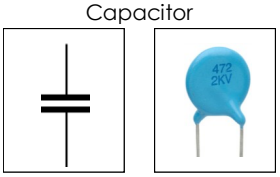
Variable Resistor



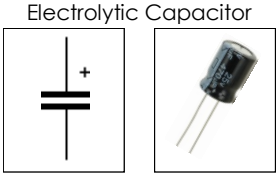
Potentiometer



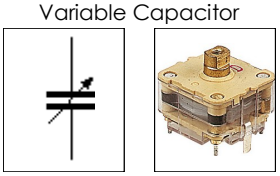
Capacitor



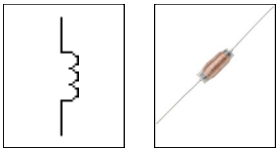
Electrolytic Capacitor



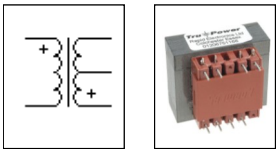
Variable Capacitor



Inductor

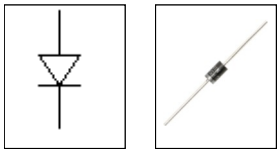


Transformer

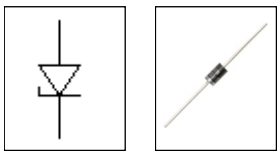


Semiconductors

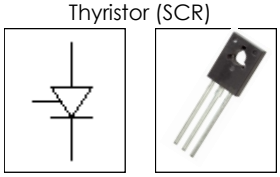
Diode



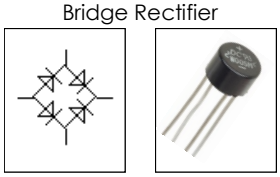
Zener Diode



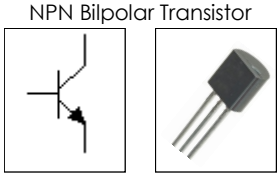
Thyristor (SCR)



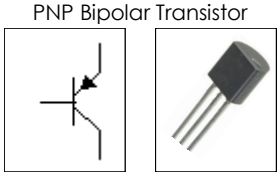
Bridge Rectifier



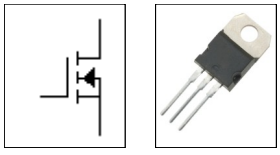
NPN Bilpolar Transistor



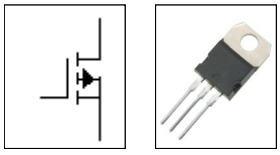
PNP Bipolar Transistor



N-Channel FET

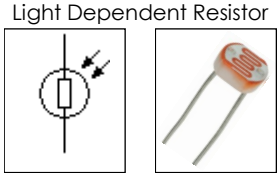


P-Channel FET

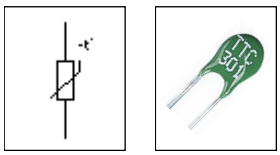


Output Components

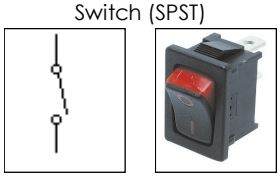
Light Dependent Resistor



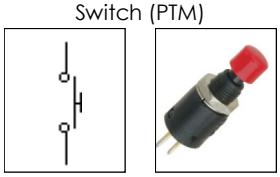
Thermistor



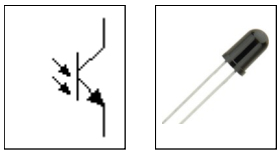
Switch (SPST)



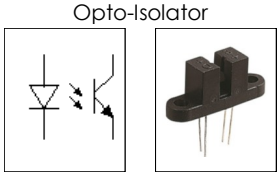
Switch (PTM)



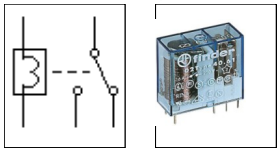
Phototransistor



Opto-Isolator



Relay



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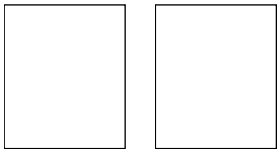

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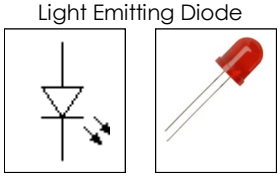
AS Systems & Control Study Notes

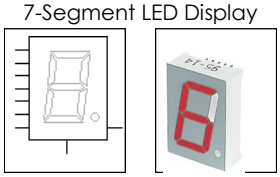
Part 1: Systems & Symbols

Output Components

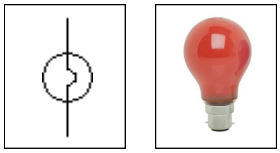
Light Emitting Diode



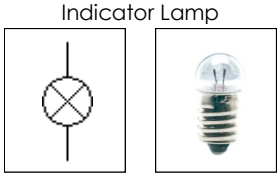
7-Segment LED Display



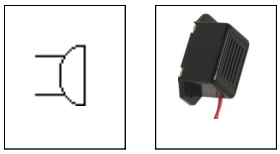
Filament Lamp



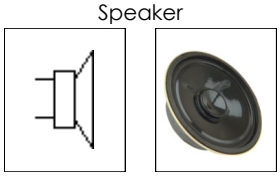
Indicator Lamp



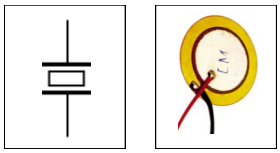
Buzzer



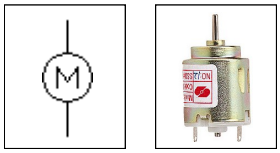
Speaker



Piezo-electric Transducer

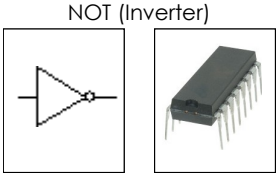


DC Motor

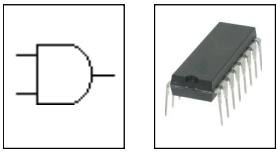


Logic Gates

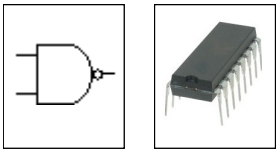
NOT (Inverter)



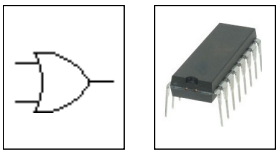
AND



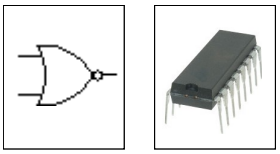
NAND



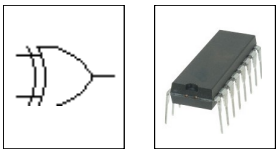
OR



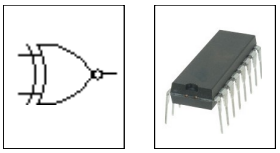
NOR



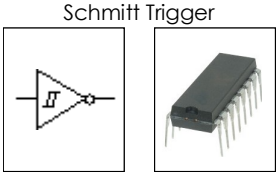
XOR



XNOR

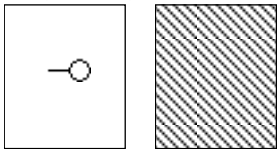


Schmitt Trigger

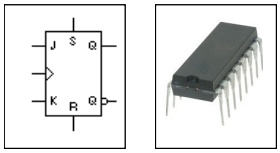


Sequential Logic

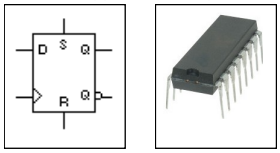
Input/Output Terminal



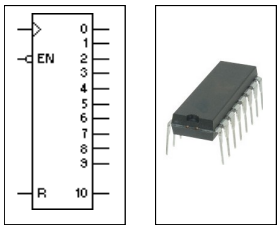
JK Flip-Flop



D-Type Flip-Flop

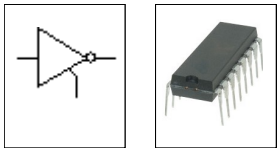


4017 Decade Counter

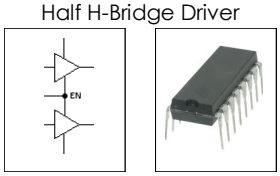


Other Integrated Circuits

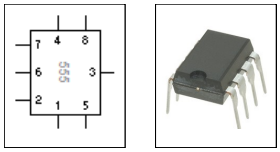
Tri-state Driver



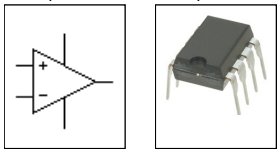
Half H-Bridge Driver



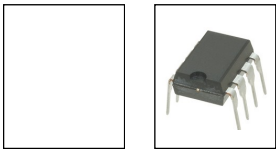
555 Timer



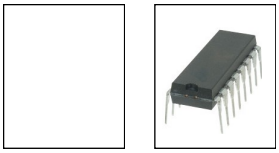
Operational Amplifier



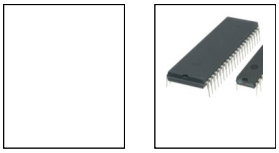
PICAXE-08



PICAXE-18



PICAXE-40



E.Clarvis 2009