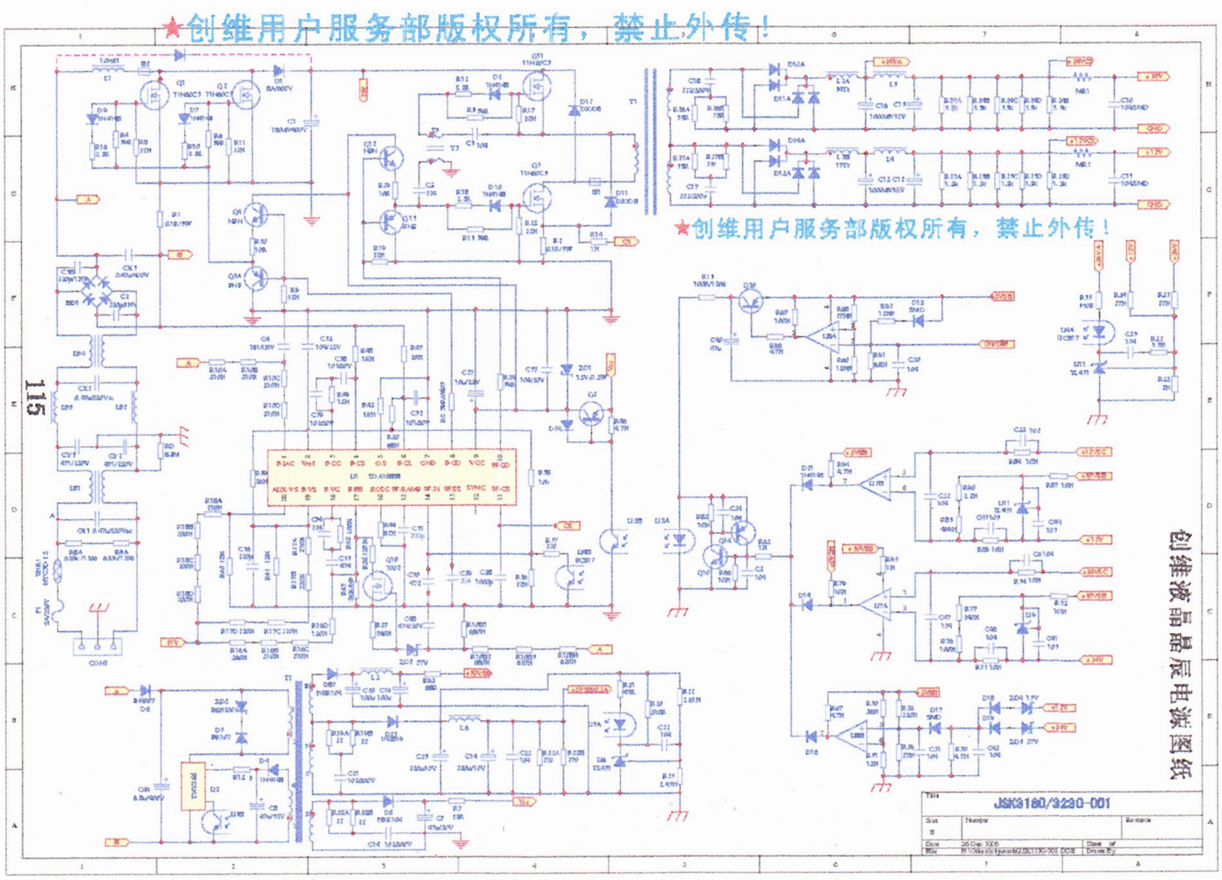
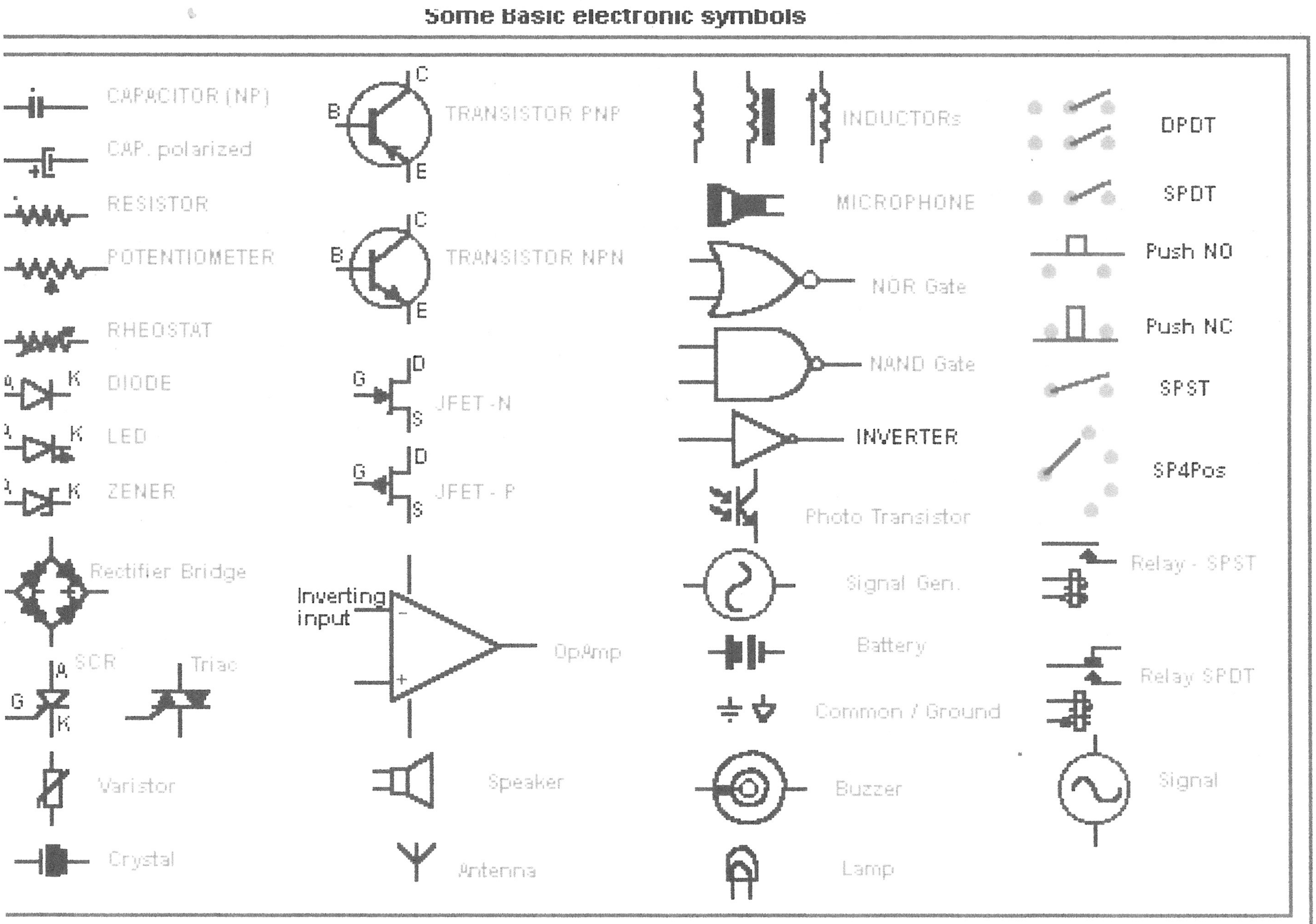
UNDERSTANDING ELECTRONIC CIRCUITS THROUGH SCHEMATIC CIRCUIT ANALYSIS

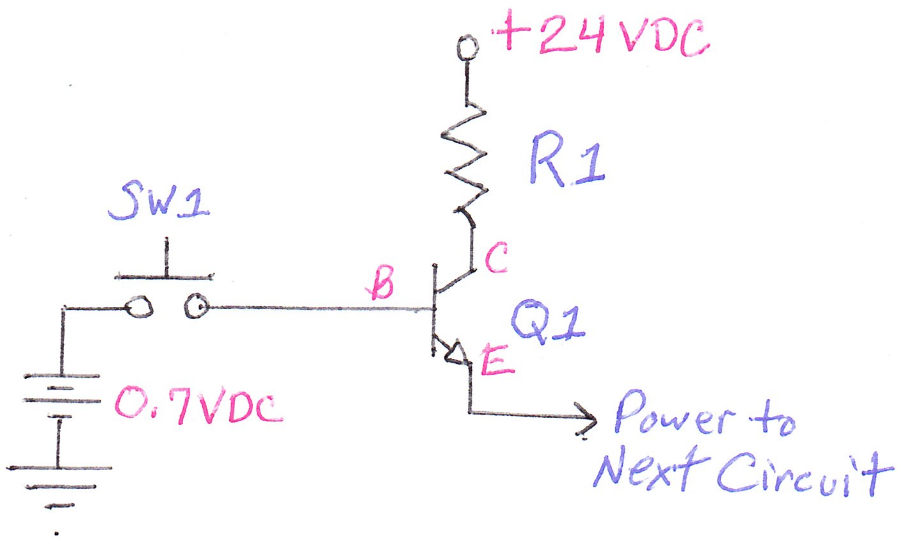
Electronic circuits are found in all types of devices of today and are used to perform all types of jobs and functions. They are at the heart of the technological revolution. When one goes to figure out how one of these circuits operate, it can seem to be a fairly complex task. Like so many other things, though, it become easier when you break it down into many smaller pieces that are joined together to make one large circuit. So that the circuit may be easily understood, symbols have been created to represent each part or piece of the circuit. They are analogous to symbols on a road map that depict towns, roads, waterways, etc. A partial listing follows on the next page of some of the more common electronic schematic symbols.




Some Basic electronic symbols
CAPACITOR (NP)
CAP. polarized
RESISTOR
POTENTIOMETER
RHEOSTAT
DIODE
LED
ZENER
Rectifier Bridge
SCR
Triac
Varistor
Crystal
TRANSISTOR PNP
TRANSISTOR NPN
JFET - N
JFET - P
Inverting input
OpAmp
Speaker
Antenna
INDUCTORs
MICROPHONE
NOR Gate
NAND Gate
INVERTER
Photo Transistor
Signal Gen.
Battery
Common / Ground
Buzzer
Lamp
DPDT
SPDT
Push NO
Push NC
SPST
SP4Pos
Relay - SPST
Relay SPDT
Signal

THE TRANSISTOR SWITCH

This is a simple circuit showing an NPN transistor used as an electronic switch.

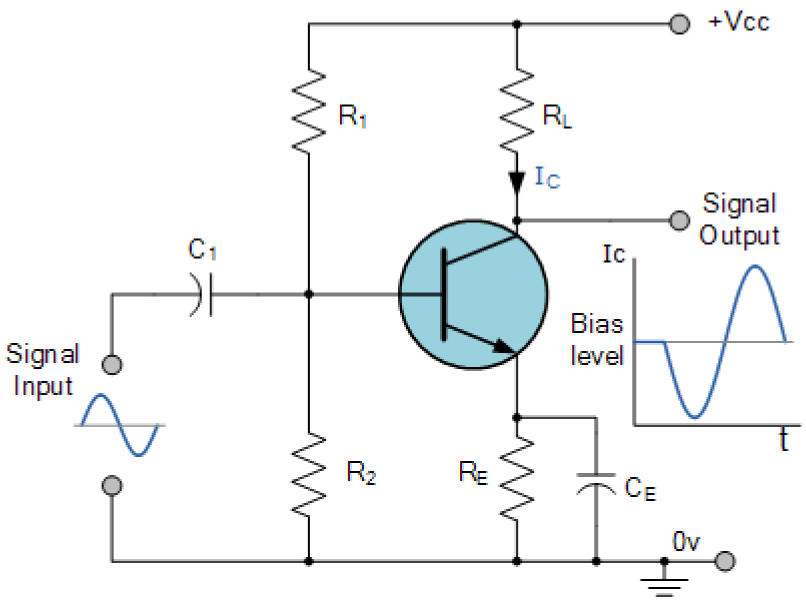


Transistor Q1 is designed to operate either fully on or off. When on, the collector to emitter junction is a dead short. When off, the collector to emitter junction is an open circuit. The transistor turns on by applying 0.7 volts DC to the base. In our circuit, a 0.7v battery is feeding a momentary mechanical switch. When the contact is made on the mechanical switch, 0.7 volts is applied to the transistor's base, turning on the collector to emitter junction. Resistor R1 is a current limiting device. A 24 volt power source supplies the transistor. The output from the emitter feeds another circuit as its power input.

that it conducts during one complete cycle of the input signal waveform producing minimum distortion and maximum amplitude of the output signal.

This means then that the **Class A Amplifier** configuration is the ideal operating mode, because there can be no crossover or switch-off distortion to the output waveform even during the negative half of the cycle. Class A power amplifier output stages may use a single power transistor or pairs of transistors connected together to share the high load current. Consider the **Class A amplifier** circuit below.

Single Stage Amplifier Circuit



This is the simplest type of Class A power amplifier circuit. It uses a single-ended transistor for its output stage with the resistive load connected directly to the Collector terminal. When the transistor switches "ON" it sinks the output current through the Collector resulting in an inevitable voltage drop across the Emitter resistance thereby limiting the negative output capability.

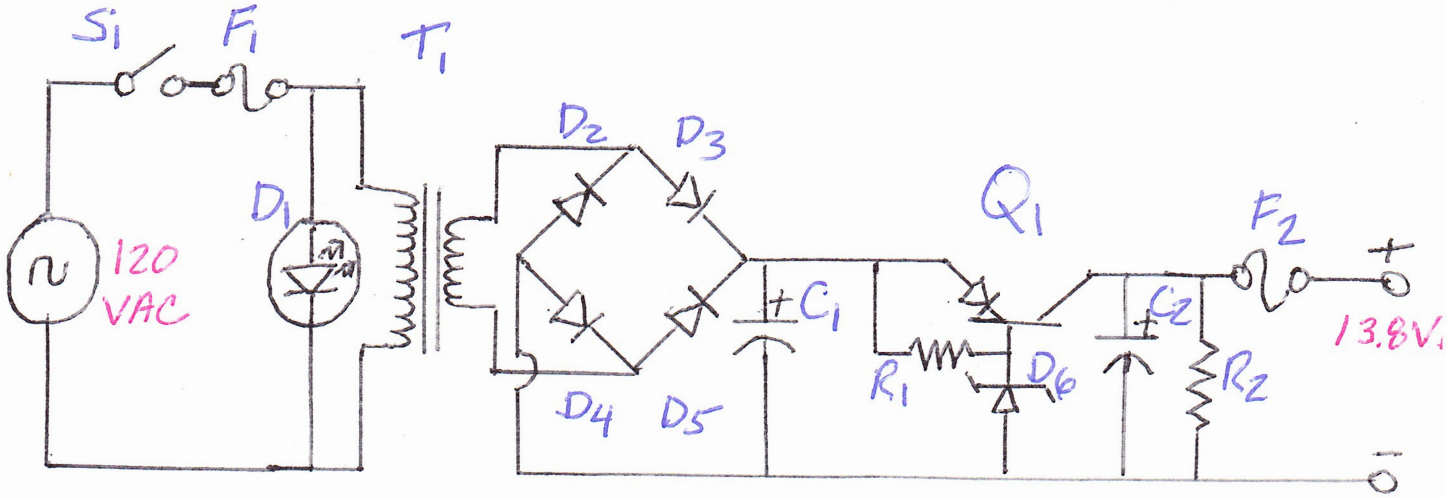
The efficiency of this type of circuit is very low (less than 30%) and delivers small power outputs for a large drain on the DC power supply. A Class A amplifier stage passes the same load current even when no input signal is applied so large heatsinks are needed for the output transistors.

However, another simple way to increase the current handling capacity of the circuit while at the same time obtain a greater power gain is to replace the single output transistor with a **Darlington Transistor**. These types of devices are basically two transistors within a single package, one small "pilot" transistor and another larger "switching" transistor. The big advantage of these devices are that the input impedance is suitably large while the output impedance is relatively low, thereby reducing the power loss and therefore the heat within the switching device.

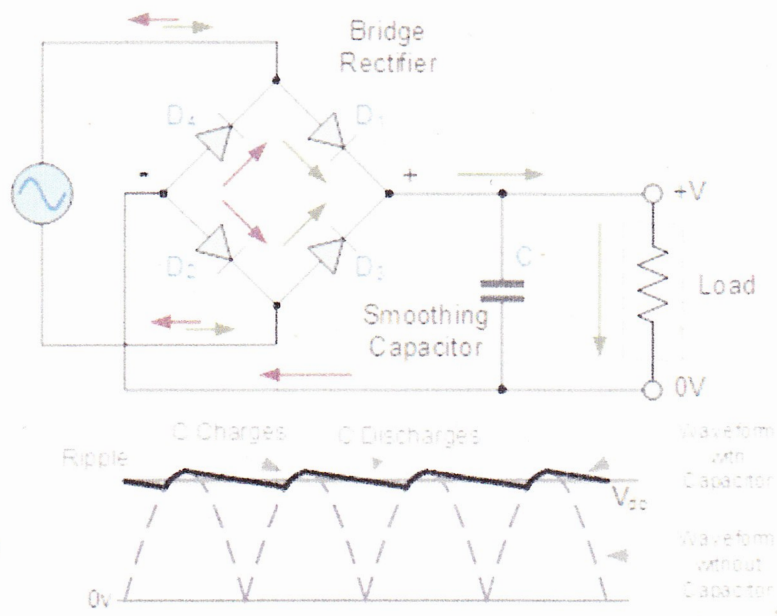
Darlington Transistor Configurations

A SIMPLE REGULATED LINEAR POWER SUPPLY

This circuit turns 120 volt household AC power into a 13.8 volt DC power supply.



Switch S1 is a common SPST front panel toggle switch. Immediately following it is a 0.5 Amp slo-blo fuse. A fast acting fuse here would not be beneficial because there is a momentary surge is current due to the transformer action. Diode D1 is a light emitting diode with and internal resistor. It is mounted on the front panel. Transformer T1 is a step down transform with a 10:1 turns ratio. Accordingly, 12 volts AC is output from the secondary. Diodes D2 through D5 make up a common bridge rectifier which turns the AC signal into a varying DC signal. Capacitor C1 smooths out the waveform as shown below.



Resultant Output Waveform

Transistor Q1 is a PNP acting as a variable resistor. Resistor R1 biases the base voltage to always be lower than the collector's, thus allowing for collector to base current. Diode D6 is a 13 volt zener. Its job is to make sure that Q1's base voltage never goes above 13 volts. The base voltage can go lower, but never above 13 volts. Capacitor C2 is there to eliminate any ripple on the DC waveform, thus creating a smooth output DC signal. Resistor R2 is to give the circuit a load when not supplying a true load. Fuse F2 protects against short circuits. This fuse is a fast acting fuse.
As the load requires more current, the emitter voltage of Q1 is pulled down, which lowers the collector voltage. In turn, the base voltage is lowered through R1. This further opens the collector to emitter gate allowing more current to flow which keeps the output voltage at its desired level. This happens in a fraction of a second. As the load requirement lessens, the emitter voltage rises, which make the collector voltage rise, which raises the base voltage, resulting in the transistor conducting less and the output voltage stays constant.