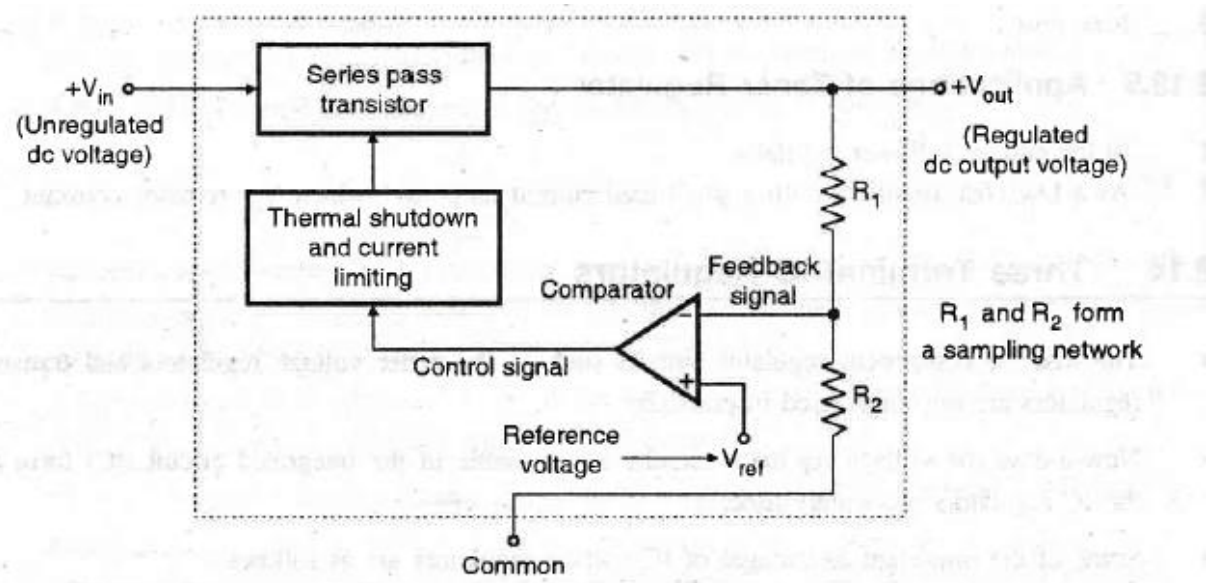
REGULATED POWER SUPPLY

The voltage regulators which are fabricated on a single silicon chip are called monolithic or IC regulators. Advantages of these regulators are small size, easy to use, high performance and low cost. Monolithic voltage regulators are three terminal devices having three terminals denoted as input, output and common terminals. These regulators are available in fixed or variable output voltage, positive or negative output voltage.

Block Diagram of Three Pin Regulator



Functional block diagram of a three pin IC voltage regulator

Fig. 1 shows simplified block diagram of three pin regulator. The three terminals are Vin (input voltage), Vout (output voltage) and common terminal. The dc unregulated voltage is applied to the terminal Vin, supply ground to common and regulated output is taken at terminal Vout.

The block diagram in fig.1 is basically a series regulator. The two resistors R_1 and R_2 form the sampling network to produce the feedback signal proportional to the output voltage. Vref is the internally generated voltage reference voltage. This reference voltage is compared with the feedback signal by the comparator to produce the control voltage. This control signal is transferred through the thermal shutdown and current limiting block to the series pass transistor. The series pass transistor is operating as the control element. The voltage across the control element is varied by the control signal to get a constant output voltage.

The thermal shutdown and current limiting block provides the protection against increased internal temperature or over current. If the internal

temperature exceeds a predetermined value, then the thermal shutdown block will not allow the control signal to pass through to the series pass transistor. This will turn off the chip automatically. The current limiting circuit protects the regulator against over current.

Three Terminal Fixed Voltage Regulators

The three terminal voltage regulators are of two types: Fixed and adjustable voltage regulators. In fixed voltage regulators we have positive voltage regulators and negative voltage regulators. The 78XX series is a series of fixed positive voltage regulators and the 79XX series is a series of fixed negative voltage regulators.

78XX Series:

78Xx series are three terminal, positive fixed voltage regulators. Here XX indicate the output voltage. These regulators are available in seven different output voltages such as 5, 6, 8, 12, 15, 18 and 24 volts. e.g. IC 7812 means +12V.

IC Number	7805	7806	7808	7812	7815	7818	7824
Output Voltage	5V	6V	8V	12V	15V	18V	24V

79XX Series:

79Xx series are three terminal, negative fixed voltage regulators. Here XX indicate the output voltage. These regulators are available in nine different output voltages such as 5, 6, 8, 12, 15, 18 and 24 volts in addition to this series provides -2 and -5.2V. e.g. IC 7812 means +12V.

IC Number	7905	7906	7908	7912	7915	7918	7924
Output Voltage	-5V	-6V	-8V	-12V	-15V	-18V	-24V

Standard connection for fixed positive voltage regulators (78XX):

The fixed voltage regulator IC's have three terminals: input, ground and output. The pin diagram of three pin regulator is shown in Fig.2 (a) and the standard connections for a three pin fixed positive regulator is shown in fig.2 (b).

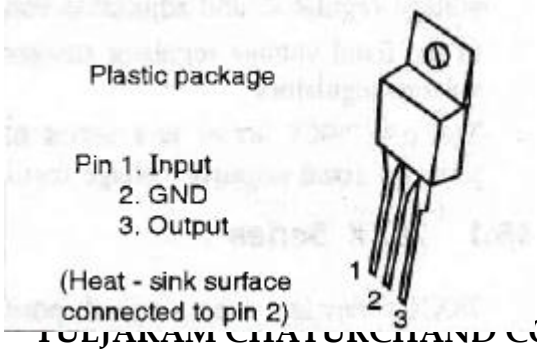
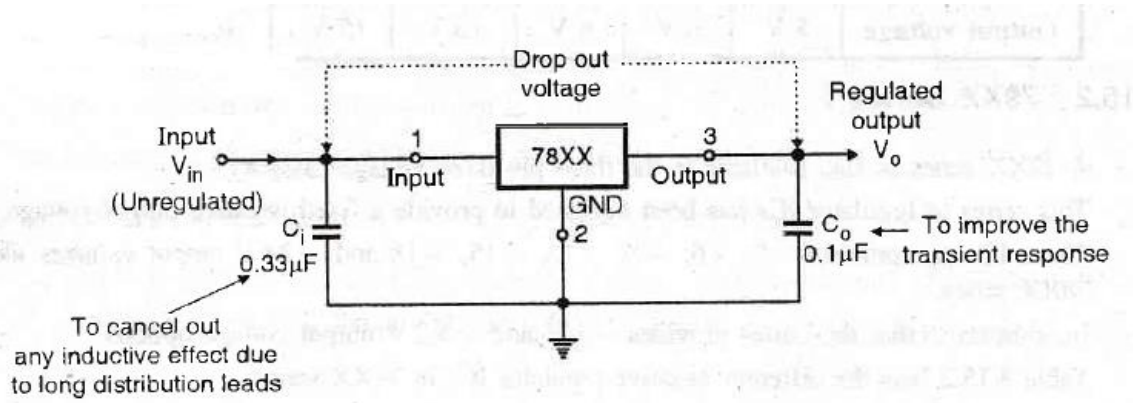


Fig. 2(a): pin diagram of three pin regulator



Standard connections for three pin fixed IC regulator

Fig.2 (b): The standard connections for a three pin fixed IC regulator.

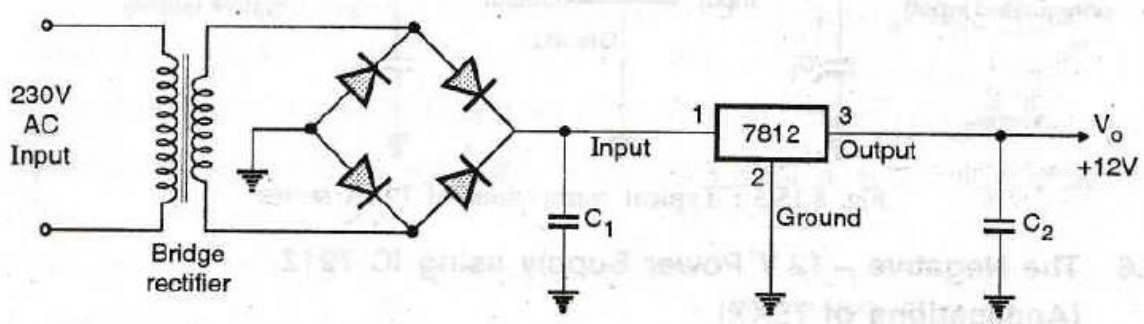
An unregulated dc voltage is applied at the input terminal of the IC. The capacitor Ci connected between the input terminal and ground cancels out any inductive effect due to long distribution leads. The output capacitor Co is used for improving the transient response of the regulator IC i.e the response of the regulator to the sudden changes in the load. This capacitor is also reduces the noise present at the output.

The difference between the unregulated input voltage Vin and the output voltage Vo is called drop out voltage. The drop out voltage need to be at least 2 volt under all the operating conditions for proper operation of regulator.

Drop out Voltage= Vin -Vout

A Positive 12 V Power supply using IC 7812:

The circuit diagram of a 12 v regulated power supply using IC 7812is shown in Fig.3



Positive 12 V dc power supply using IC 7812

The bridge rectifier and capacitor input filter produce an unregulated dc voltage which is applied at the Input terminal of IC 7812. As the minimum drop out voltage is 2v for Ic 7812, the voltage applied at the Input terminal should be at least 14V. C_1 is the filter capacitor and C_2 is connected at the output terminal to improve the transient response of the regulator.

Negative voltage regulators (79XX):

The fixed voltage regulator IC's have three terminals: input, ground and output. The pin diagram of three pin regulator is shown in Fig.2 (a) and the standard connections for a three pin fixed negative regulator is shown in fig.2 (b).

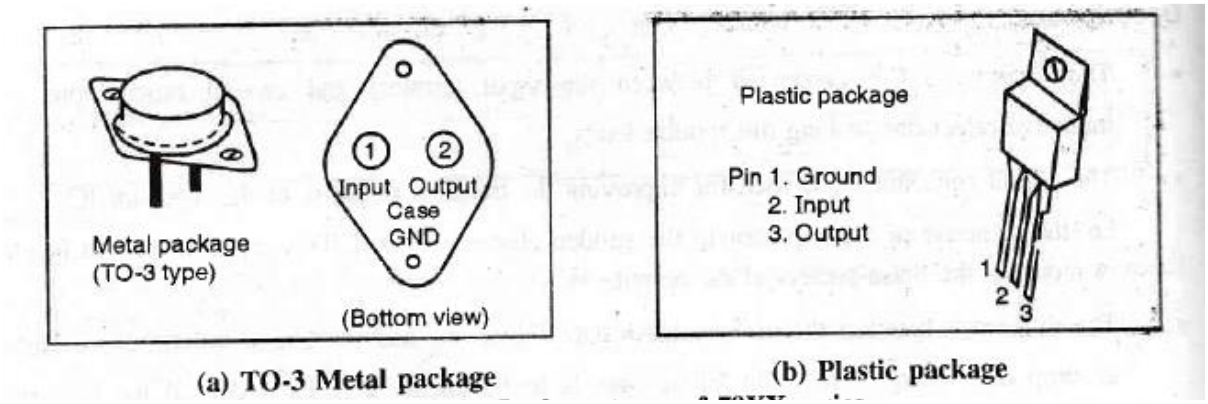


Fig. 3(a): pin diagram of three pin regulator

Standard connection for fixed negative voltage regulators (79XX):

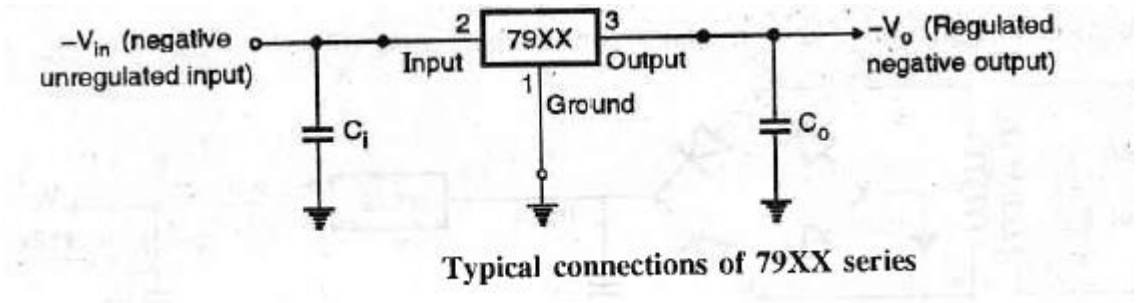


Fig.3 (b): The standard connections for a three pin fixed IC regulator.

An unregulated dc voltage is applied at the input terminal of the IC. The capacitor C_i connected between the input terminal and ground cancels out any inductive effect due to long distribution leads. The output capacitor C_o is used for improving the transient response of the regulator IC i.e the response of the regulator

to the sudden changes in the load. This capacitor is also reduces the noise present at the output.

The difference between the unregulated input voltage V_{in} and the output voltage V_o is called drop out voltage. The drop out voltage need to be at least 2 volt under all the operating conditions for proper operation of regulator.

Drop out Voltage= V_{in} -V_{out}

A Negative 12 V Power supply using IC 7912:

The circuit diagram of a -12 V regulated power supply using IC 7912 is shown in Fig.4

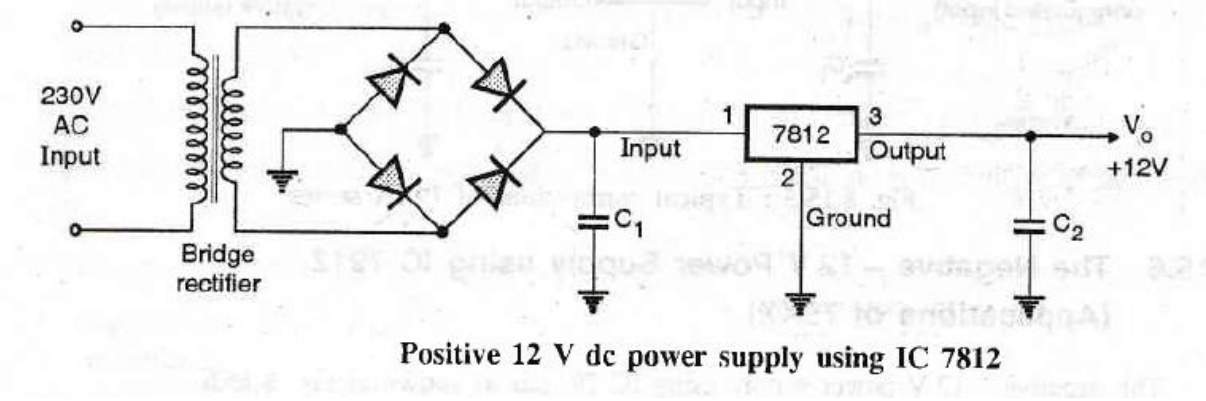


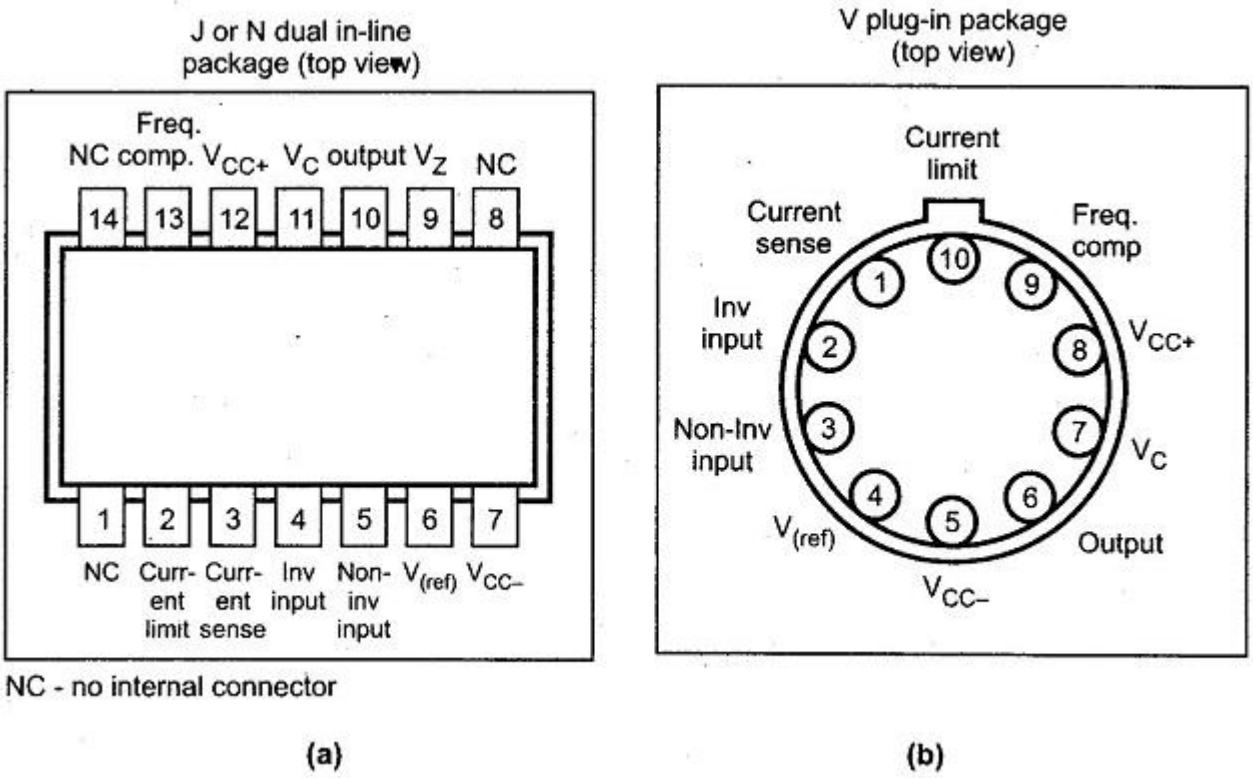
Fig.4: A Negative 12 V Power supply using IC 7912

A full wave rectifier and capacitor filter C_i produces the unregulated negative dc input to the regulator IC. At the output of 7912, we get a regulated output of -12V.

Linear IC 723 Regulator:

The popular general purpose precision regulator is Linear IC 723 Regulator. It is a monolithic linear integrated circuit in different physical packages.

The pin diagram along with the various packages is shown in the Fig. 1 (a), (b).



Important Features of IC 723:

1. It works as voltage regulator at output voltage ranging from 2 to 37 volts at currents upto 150 mA.
2. It can be used at load currents greater than 150 mA with use of suitable NPN or PNP external pass transistors.
3. Input and output short-circuit protection is provided.
4. It has good line and load regulation (0.03%)
5. Wide variety of applications of series, shunt, switching and floating regulator.
6. Low temperature drift and high ripple rejection.
7. Small size, lower cost
8. Relative ease with which power supply can be designed.
9. It provides a choice of supply voltage.

Internal Structure of IC 723:

The functional block diagram of IC 723 can be divided into four major blocks

1. Temperature compensated voltage reference source, which is zener diode.
2. An op-amp circuit used as an error amplifier.
3. A series pass transistor capable of a 150 mA output current.
4. Transistor used to limit output current.

The functioning of the above blocks can be explained with the help of a simplified functional block diagram of IC 723 as shown in the Fig. 2.

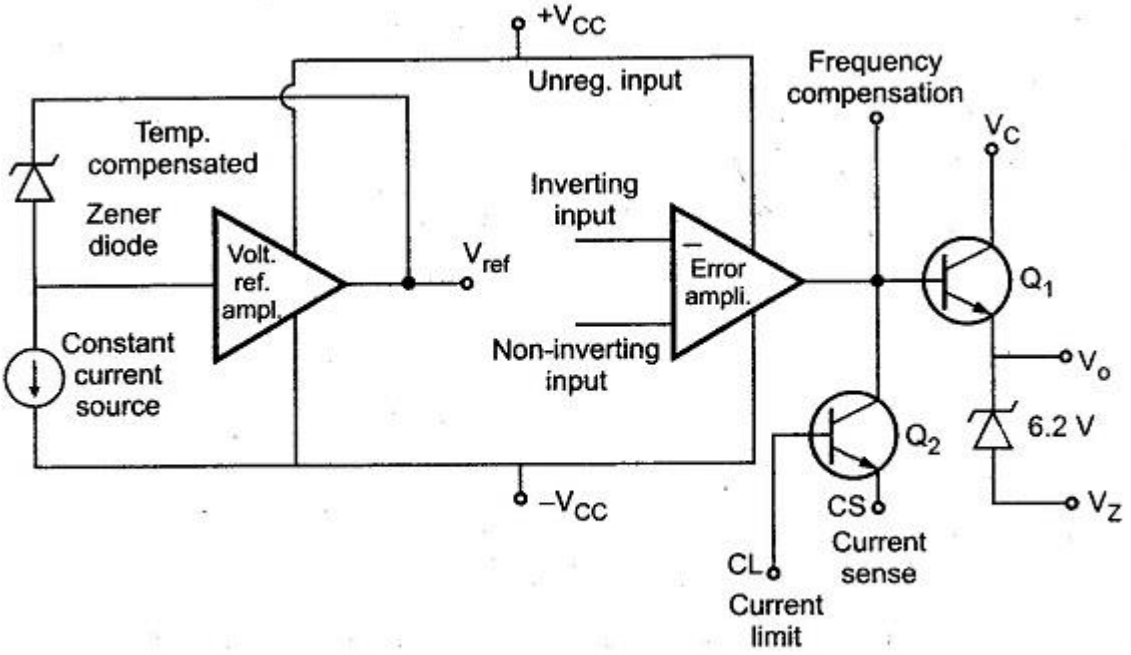


Fig. 2.110 Functional block diagram

Temperature compensated zener diode, constant current source and reference amplifier constitutes the reference element. In order to get a fixed voltage from zener diode, the constant current source forces the zener to operate at a fixed point.

Output voltage is compared with this temperature compensated reference potential of the order of 7 volts. For this V_{ref} is connected to the non-inverting input of the error amplifier.

This error amplifier is high gain differential amplifier. It's inverting input is connected to the either whole regulated output voltage or part of that from outside. Error amplifier controls the series pass transistor Qi, which acts as variable resistor. The series pass transistor is a small power transistor having about 800 mW dissipation. The unregulated power supply source (< 36V d.c.) is connected to collector of series pass transistor.

Transistor Q2 acts as current limiter in case of short circuit condition. It senses drop across Rsc placed in series with regulated output voltage externally.

The frequency compensation terminal controls the frequency response of the error amplifier. The internal structure can be represented in more simplified form as shown in the Fig. 2.111.

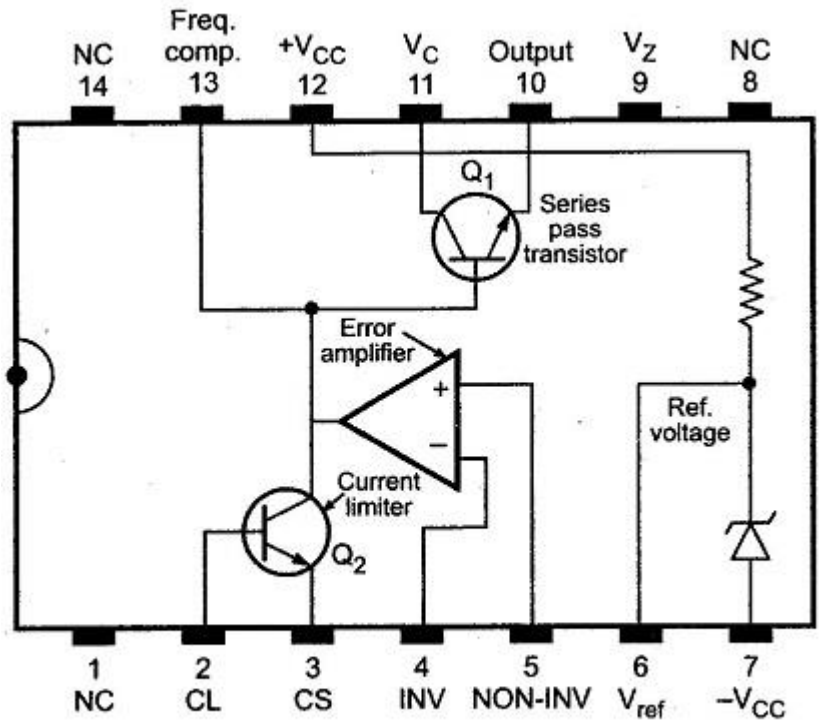


Fig. 2.111 Simplified internal structure of IC 723

Both non inverting and inverting terminals of the error amplifier are available on outside pins of IC 723. Due to this, device becomes versatile and flexible to use. Only restriction is that internal reference voltage is 7 volts and therefore we have to use two different circuits for getting regulated outputs of below 7 volts and above 7 volts.