

# Different Types of Voltage Regulator ICs

## I. Introduction

A voltage regulator is a system designed to automatically maintain a constant voltage. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

The function of a voltage regulator is to maintain a constant DC voltage at the output irrespective of voltage fluctuations at the input and (or) variations in the load current. In other words, voltage regulator produces a regulated DC output voltage.

## II. Types of voltage regulator

Voltage regulators are also available in Integrated Circuits (IC) forms. These are called as voltage regulator ICs. There are two types of voltage regulators which are

- A. Fixed Voltage Regulator
- B. Adjustable Voltage Regulators

### A. Fixed voltage regulators

Fixed voltage regulator A fixed voltage regulator produces a fixed DC output voltage, which is either positive or negative. In other words, some fixed voltage regulators produce positive fixed DC voltage values, while others produce negative fixed DC voltage values.

Examples: - 7805,7809,7812,7824 these types of Integrated Circuit or ICs are called fixed voltage regulator. But some type of ICs like AMS1117, LM2596 and LM317 that are also used as fixed voltage regulator. Here LM stands for Linear Monolithic.

1. **LM7805:** A LM7805 Voltage Regulator is a voltage regulator that outputs +5 volts. An easy way to remember the voltage output by a LM78XX series of voltage regulators is the last two digits of the number. A LM7805 ends with "05"; thus, it outputs 5 volts. The "78" part is just the convention that the chip makers use to denote the series of regulators that output positive voltage. The other series of regulators, the LM79XX, is the series that outputs negative voltage.

**General Description:** - The LM7805 series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially intractable. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

**Specifications:** - The LM7805 type of voltage regulator ICs have following specifications

1. 5V Positive Voltage Regulator
2. Minimum Input Voltage is 7V
3. Maximum Input Voltage is 25V
4. Operating current ( $I_Q$ ) is 5mA
5. Internal Thermal Overload and Short circuit current limiting protection is available.
6. Junction Temperature maximum 125 degree Celsius
7. Available in TO-220 and KTE package

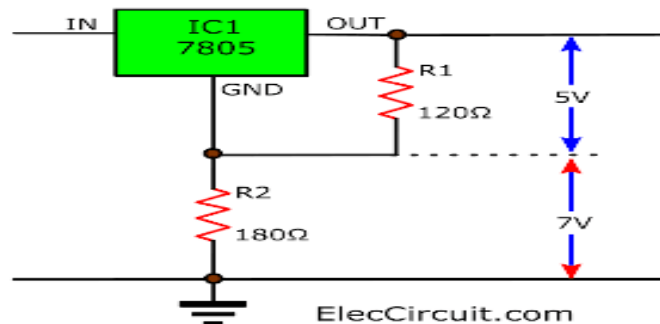
**PIN OUT DIAGRAM: -**

Pin No.	Name	Function
1	Input	Input Voltage (5 to 18 V)
2	Ground	Ground
3	Output	Output Regulated Voltage (4.8 to 5.2 V)



**7805 Pinout**

**Application Diagram: - 5V generation using 7805 regulators**



The following formula is used when 5V is the nominal output voltage (output to common) of the fixed regulator

$$V_{out} = 5V + (5V/R1 + I_Q) R2$$

For example:  $R1=120$ ,  $R2= 180$ ,  $I_Q = 5mA$  (0.005A)

$$V_{out} = 5V + (5V/120 + 0.005)180 = 13.4 V$$

**Manufacturers: -** UTC, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI (LM7805), FCI, ST Microelectronics (L7805CV), ON (7805T),

2. **LM7809:** - 7809 Voltage regulators is a type of self-contained fixed linear voltage regulator integrated circuit. The IC belongs to 78xx voltage regulator family which is commonly used as the regulated power supply in electronic circuits The IC 7809 is not as popular as IC 7805.

**General Description:** - The 7809 9V fixed 3-terminal positive voltage regulator delivers up to 1.5A of output current with adequate heat-sinking. The device is equipped with internal limiting, safe-area compensation + thermal shutdown features for overload immunity. The 7809 can be used with external components to obtain adjustable voltages or currents & can also be used as the power-pass element in precision high-current voltage regulators.

**Specifications:** -

- 9V Positive Voltage Regulator
- Minimum Input Voltage is 11V
- Maximum Input Voltage is 35V
- Output Current: 1.5 A
- PSRR / Ripple Rejection: 55 dB
- Output Type: Fixed
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum of 125 degree Celsius
- Available in TO-220, TO-3 and KTE package

**Pin Out Diagram:** -

**LM7809 Pinout Configuration**

Pin Number	Pin Name	Description
1	Input (V+)	Unregulated Input Voltage
2	Ground	Connected to Ground
3	Output (Vo)	Outputs Regulated +9V



**Application Diagram:** -

**Manufacturers:** UTC, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI (LM7809), FCI, ST Microelectronics (L7809CV), ON (7809T),

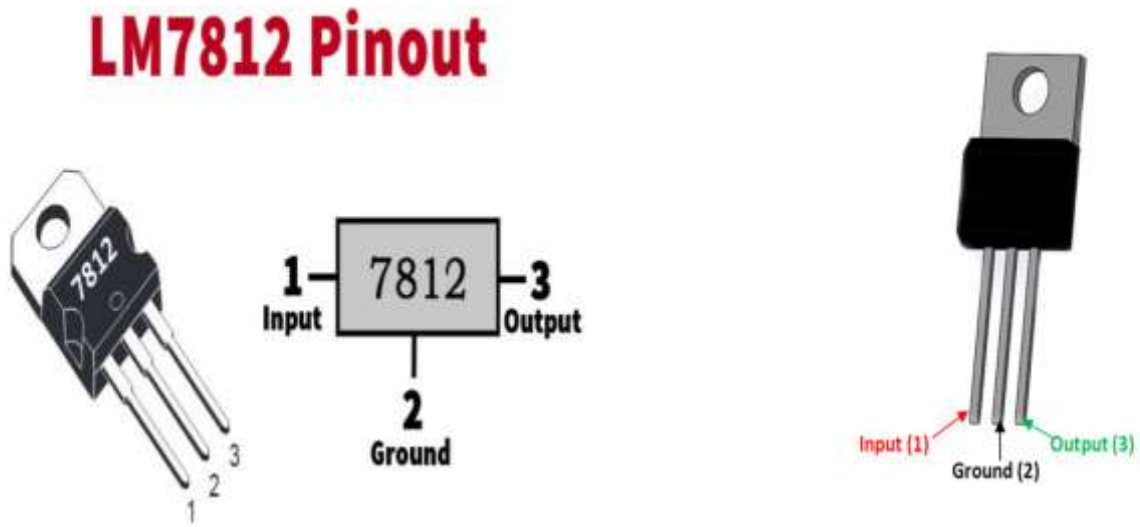
3. **LM7812:** - LM7812 is an accurate power transistor with synchronous rectification features as well as a wide frequency response. The maximum output voltage of LM7812 IC is around 12V DC with a minimum input voltage range of 0.25V to 3V.

**General Description:** - The 7812 12V fixed 3-terminal positive voltage regulator delivers up to 1.5A of output current with adequate heat-sinking. The device is equipped with internal limiting, safe-area compensation + thermal shutdown features for overload immunity. The 7809 can be used with external components to obtain adjustable voltages or currents & can also be used as the power-pass element in precision high-current voltage regulators.

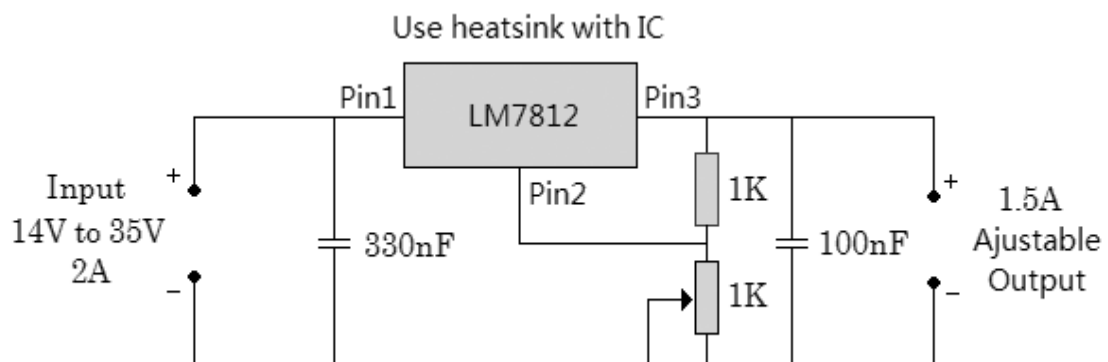
**Specifications:** -

- Output Current of 1.5A
- Output Voltage Tolerance of 5%
- Internal thermal overload protection
- Internal Short-Circuit Limited
- No External Component
- Output Voltage 12V
- Offer in plastic TO-252, TO-220 & TO-263

**Pin Out Diagram:** -



**Application diagram:** - 12volt generation using 7812



**Manufacturers:** - UTC, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI (LM7812), FCI, ST Microelectronics (L7812), ON (7812T).

4. **LM7824:** - LM7824 is a fixed-voltage integrated-circuit voltage regulator designed for a wide range of applications. The LM7824 voltage regulator provides 24V Positive voltage as output to provide a convenient power source for most TTL components. Although designed primarily as a fixed voltage regulator, but it can be used with external components to obtain adjustable voltage.

**General description:** - 7824 Voltage regulators is a type of self-contained fixed linear voltage regulator integrated circuit. The IC belongs to a 78xx voltage regulator family which is commonly used as the regulated power supply in electronic circuits. The 7824-voltage regulator IC is ease-of-use and available in very low cost. The last two digits of 7824 indicate the output voltage that is the voltage. The 7824 Voltage regulators do operate at their optimal capability if the input voltage is at least 2.5 volts greater than the output voltage and the current is 1 or 1.5 Amperes more. Though the voltage and current ratings are different for other IC Packages.

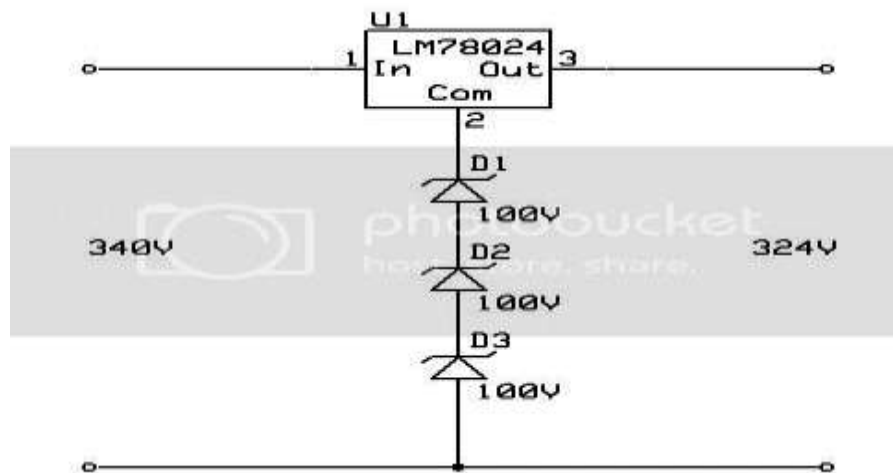
**Specifications: -**

- TO-220 Package
- Up to 1.5 Ampere output current capability
- Built-in short circuit protection function
- Built-in overheat protection function
- Can be reliably used in commercial devices
- Fixed and accurate 24V DC output
- Maximum input voltage is 35V To 40V DC
- Low quiescent current only 8mA
- Low price

**Pinout Diagram: -**



### Application Diagram: -



**Manufacturers:** - UTC, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI (LM7824), FCI, ST Microelectronics (L7824CV), ON (7824T),

**NOTE:** - LM7905, LM7912, LM7915 etc. are working as LM78xx series regulator. But they provide negative voltage.

## B. Adjustable Voltage Regulators

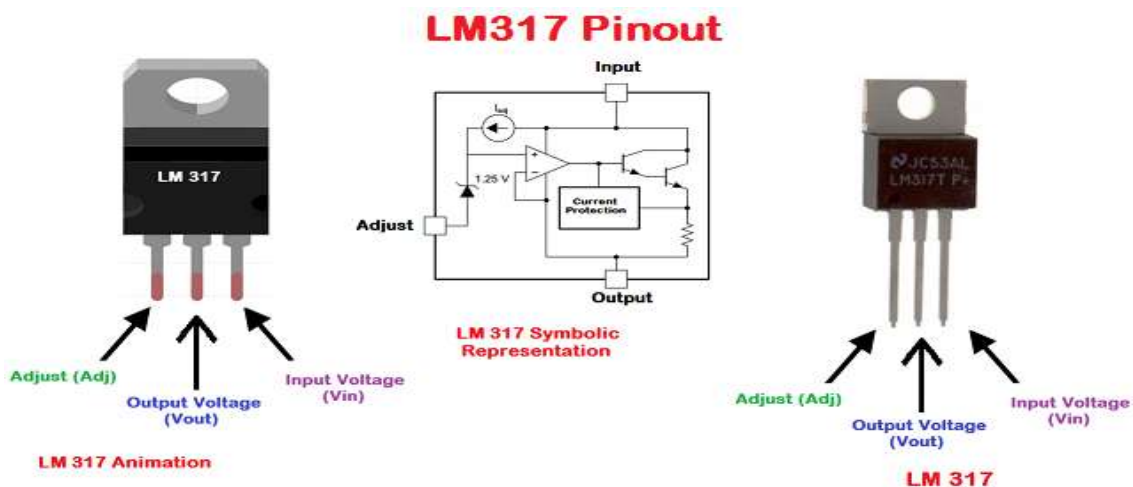
5. **LM317:** - The LM317 Voltage Regulator is a 3-terminal adjustable voltage regulator which can supply an output voltage adjustable from 1.2V to 37V. It can supply more than 1.5A of load current to a load. LM317 Pinout LM317 Schematic Diagram.

**General Description:** - The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage. The device features a typical line regulation of 0.01% and typical load regulation of 0.1%. It includes current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected.

### Specifications: -

- Output voltage range adjustable from 1.25 V to 37 V
- Output current greater than 1.5 A
- Internal short-circuit current limiting
- Thermal overload protection
- Output safe-area compensation

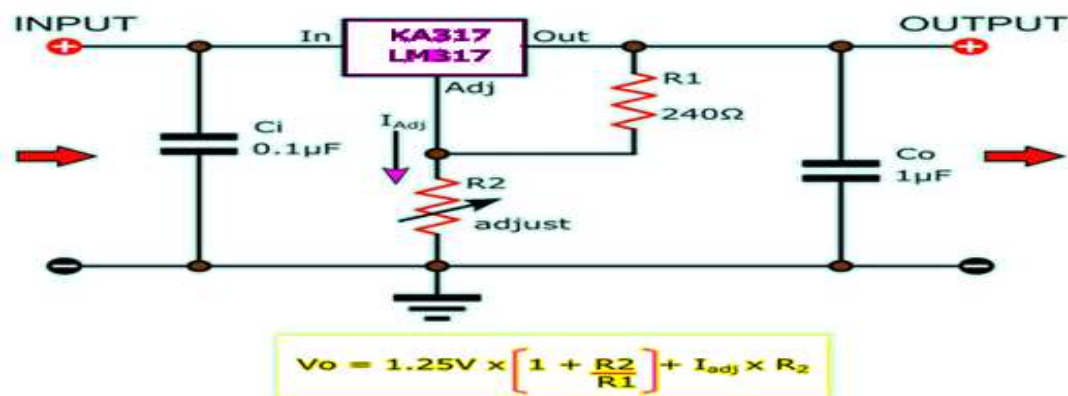
**Pinout Diagram: -**



**Application Diagram: -**

**Manufacturers:** - UTC, FAIRCHILD, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI, FCI.

6. **AMS1117:** - The AMS1117 is a popular SMD package 3-pin voltage regulator that is available in many models for fixed and adjustable voltage requirements. The IC can deliver a maximum current of 1A and the output voltage can vary from 1.5V to 5V. It also has a low drop out voltage of 1.3V when operating at maximum current.



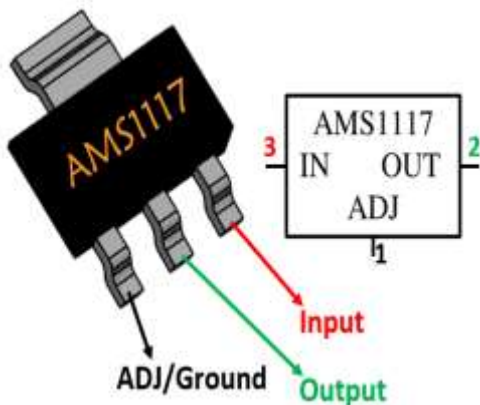
**General Description:** - The AMS1117 series of adjustable and fixed voltage regulators are designed to provide up to 1A output current and to operate down to 1V input-to-output differential.

The dropout voltage of the device is guaranteed maximum 1.3V, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1.5%. Current limit is set to minimize the stress under overload conditions on both the regulator and power source circuitry. The AMS1117 devices are pin compatible with other three-terminal SCSII regulators and are offered in the low-profile surface mount SOT-223 package, in the 8L SOIC package and in the TO-252 (DPAK) plastic package.

**Specifications: -**

- Fixed/Adjustable 3-terminal Linear voltage regulator
- Low Drop-Out (LDO) Voltage regulator
- Fixed Voltage type: 1.5V, 1.8V, 2.5V, 2.85V, 3.3V and 5V
- Variable Voltage range: 1.25V to 13.8V
- Output current is 1000mA
- Maximum Drop-out Voltage: 1.3V
- In-built Current Limiting and thermal protection.
- Operating junction temperature is 125°C
- Available in SOT-223, TO-252 and SO-8 Package

**Pinout Diagram: -**

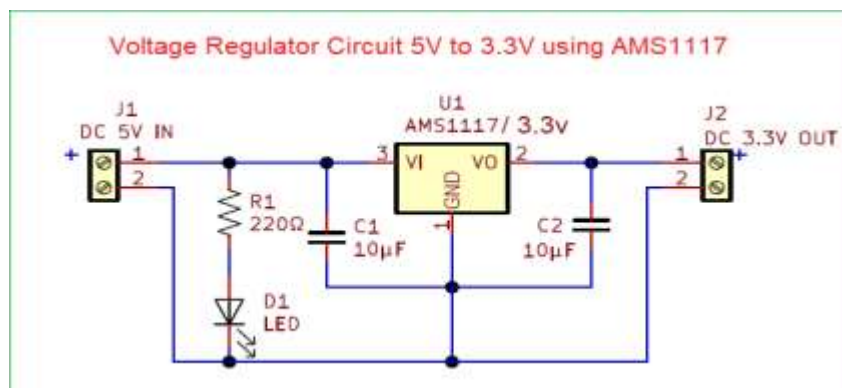


**Pin Configuration**

Pin Number	Pin Name	Description
1	Adjust/Ground	This pins adjusts the output voltage, if it is a fixed voltage regulator it acts as ground
2	Output Voltage (Vout)	The regulated output voltage set by the adjust pin can be obtained from this pin
3	Input Voltage (Vin)	The input voltage which has to be regulated is given to this pin

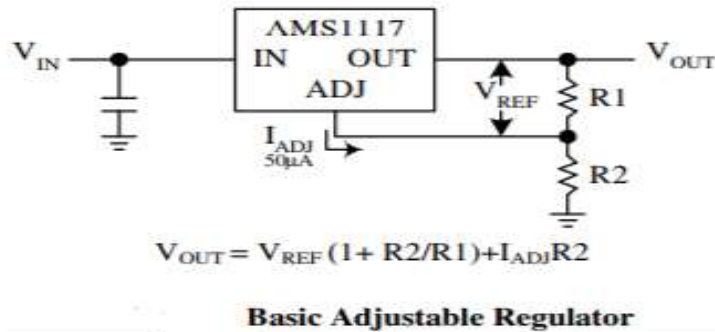
**Application Diagram: -**

**1. 3.3V generation using AMS1117**

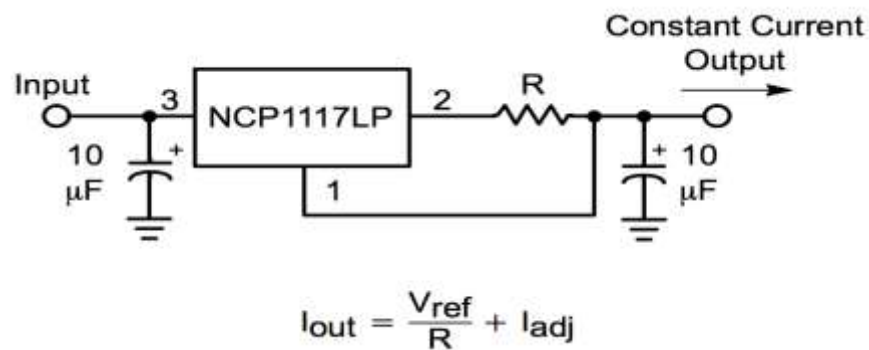




2. Basic voltage generation using AMS1117



3. Basic constant generation using AMS1117



**Manufacturers:** -AMS, UTC, FAIRCHILD, TAITRON, TI, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI, FCI, Texas (LM1117)

7. **LM2596:** - The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

**General Description:** - The LM2596 is a commonly used popular step-down switching regulator IC. The adjustable version can take in input voltage from 4.5V to 40V and convert it to variable voltage sourcing up to of 3A of continuous current. Because of its high current capability is commonly used in power modules to power/control heavy loads.

**Specifications:** -

- 3A Step Down Voltage Regulator IC
- Available as 3.3V regulator, 5V Regulator, 12V Regulator and Variable regulator

- Input Supply Voltage: 4.5V to 40V
- Minimum Output Voltage: 3.16V
- Continuous Output Current: 3A
- Peak Output Current: 6.9A
- Switching Frequency: 150KHz
- Available in To-220 and To-263 Package

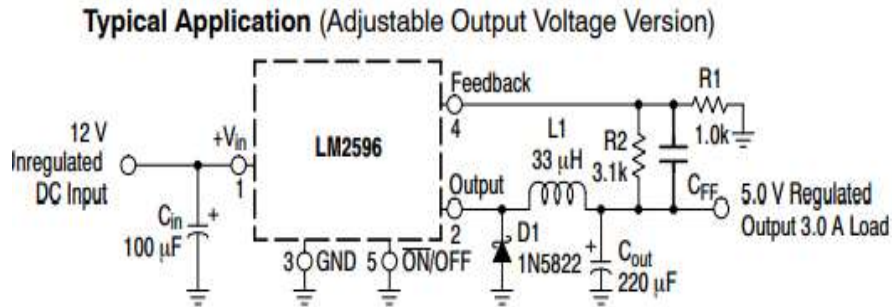
**Pinout Diagram: -**



Pin Number	Pin Name	Description
1	V-IN	Input voltage that is to be regulated
2	V-OUT	Stepped down Regulated output Voltage
3	Ground	Connected to system ground
4	Feedback	Sets the output voltage using divider network using output voltage feedback
5	ON/OFF	Enable pin, should be grounded for normal operation

**Application Diagram: -**

**1. 5 volt generation using LM2596: -**

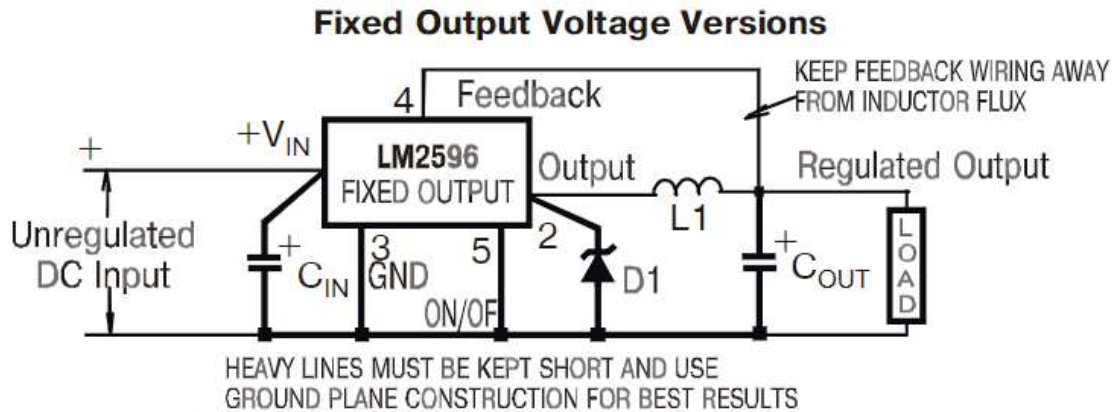


As told earlier the output voltage of the **LM2596-ADJ** can be controlled by using the feedback pin. The above circuit diagram shows the feedback pin getting the feedback voltage from a voltage divider circuit formed with Resistors R1 and R2. The value of this R1 and R2 decides the output voltage of the IC. The formula to calculate R1 and R2 is given below.

$$V_{out} = V_{ref} (1.0 + R2/R1)$$

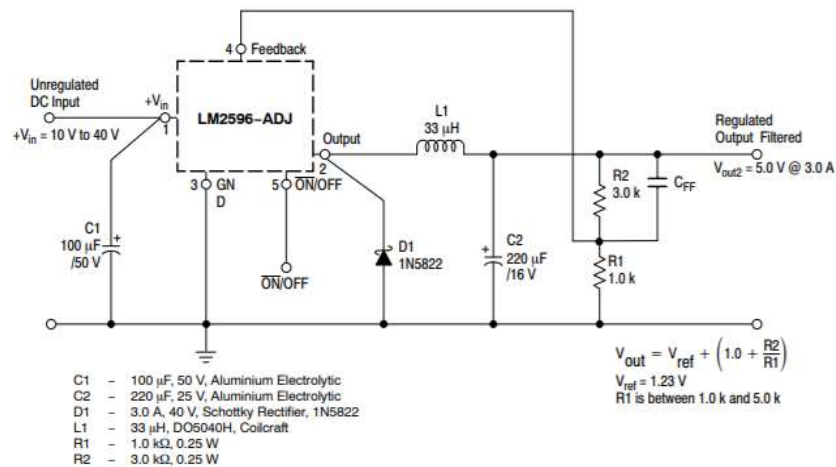
Here the value of  $V_{ref}$  can be considered as 1.23V hence the formula becomes  $V_{out} = 1.23 \cdot (1 + (R2/R1))$ , where the value of  $R1$  should be between 1k to 5k. It is also possible to use a variable resistor in place of  $R1$  to control the output voltage.

2. Fixed output voltage version: -



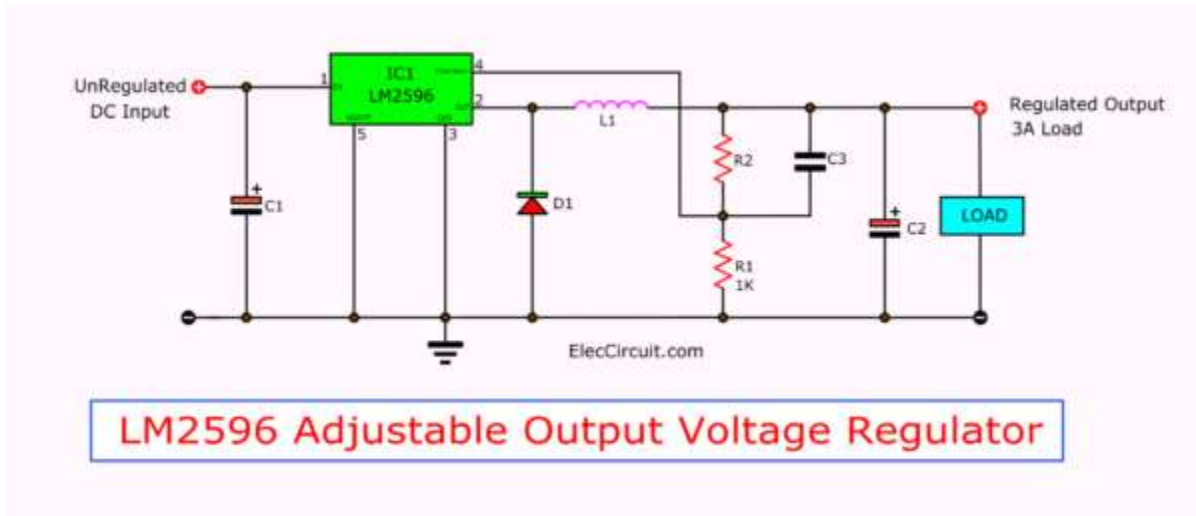
- $C_{in}$  - 470 $\mu$ F, 50V, Aluminum Electrolytic Nichicon "PL Series"
- $C_{out}$  - 220 $\mu$ F, 25V, Aluminum Electrolytic Nichicon "PL Series"
- D1 - 5A, 40V Schottky Rectifier, 1N5825
- L1 - 68 $\mu$ H, L38

3. The lm2596 step-down voltage regulator with 5.0 v @ 3.0 an output power capability. Typical application



**Schematic Diagram of the 5.0 V @ 3.0 A Step-Down Converter Using the LM2596-ADJ**

#### 4. The lm2596 adjustable output voltage regulator:-



Please ensure that the input voltage is higher than the output voltage. In the general input is 3.2V to 40V. And the output is 1.23V to 35V.

We just only add R1 and R2 to Feedback lead. To control the output voltage.

$$V_{out} = V_{REF} \left\{ \left( 1 + \frac{R2}{R1} \right) \right\} \text{ where } V_{REF} = 1.23V$$
$$R1: 1K$$
$$R2 = R1 \left\{ \left( \frac{V_{out}}{V_{REF}} \right) - 1 \right\}$$

#### Parts list

C1: 470uF 50V Electrolytic

C2: 220uF 50V Electrolytic

D1: 5A, 40V Schottky Rectifier, 1N5825

L1: 68uH

R1: 1K, 0.25W 1% resistor

C3: 0.0033uF

**Manufacturers:** - TEXAS, CYSTECH ELECTRONICS, ON SEMICONDUCTOR, ARTSCHIP ELECTRONICS, HTC KOREA

## Some Different Type of Model of LM2596: -

- LM2596-12F5
- LM2596-33E5
- LM2596-ADJ
- LM2596-XXES
- LM2596DSADJG

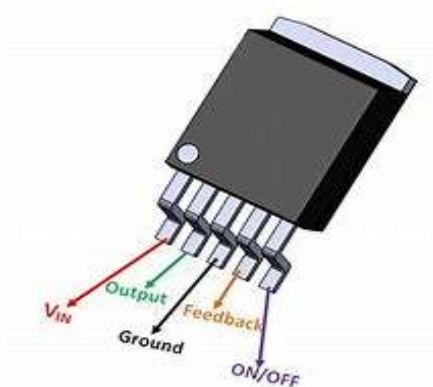
8. **LM2576:** - The LM2576 is a high-efficiency Buck regulator which is used in a large variety of applications which include Designing of Switch-mode power supplies. It is an efficient pre-regulator for designing Linear Regulators. These are On-Card Switching Regulators. It can also be used to convert a positive input voltage to negative output voltage.

**General Description:** - The LM2576 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, 15 V, and an adjustable output version.

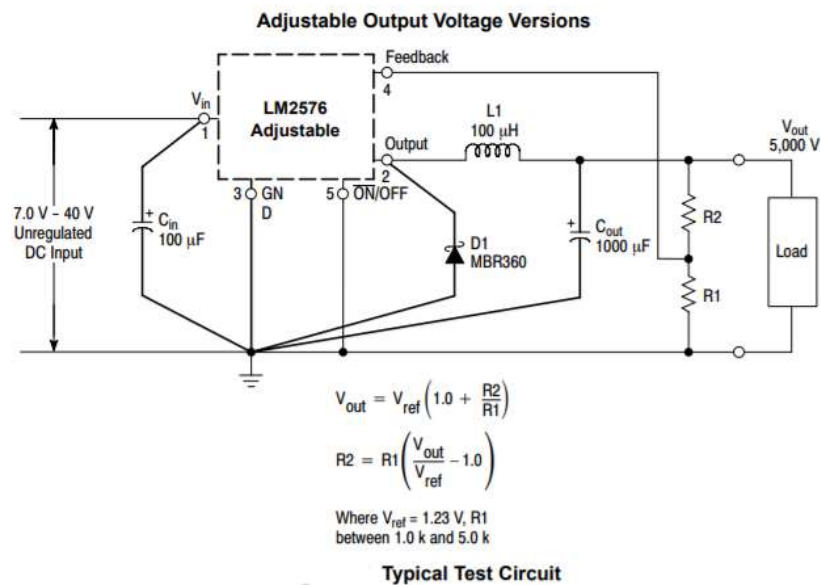
### Specification: -

- Adjustable version output voltage range, 1.23 V to 37 V (57 V for HV version)  $\pm 4\%$  maximum over line and load conditions
- Specified 3-A output current
- Wide input voltage range: 40 V Up to 60 V for HV version
- Requires only four external components
- 52-kHz fixed-frequency internal oscillator
- TTL-shutdown capability, low-power standby mode
- High efficiency
- 3.3-V, 5-V, 12-V, 15-V, and adjustable output versions

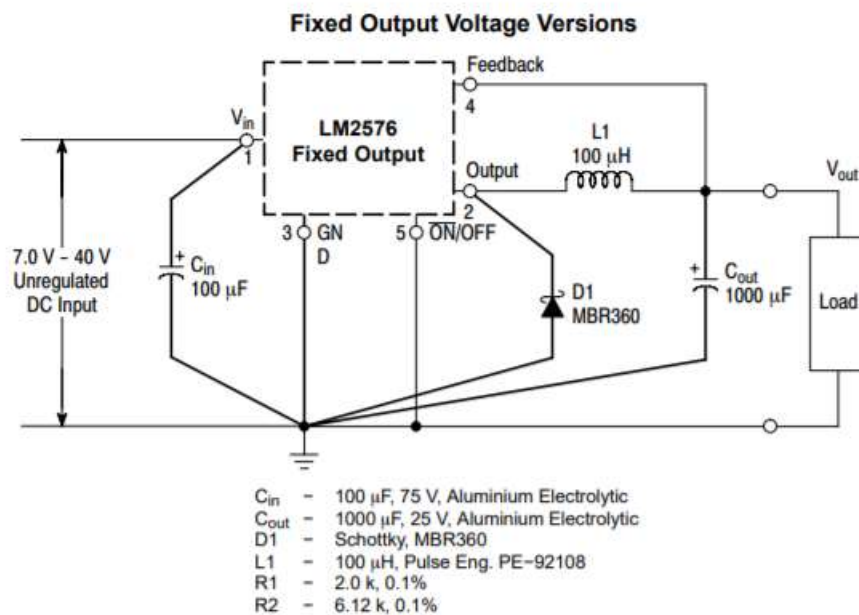
### Pinout Diagram: -



## Application Diagram: -



## LM2576



**Manufacturers:** - UTC, FAIRCHILD, TAITRON, TII, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI, FCI, TEXAS (LM2596T), ON (LM2946S).

9. **RC4195:** - A dual-tracking regulator is used when split-supply voltages are needed. These provide equal positive and negative output voltages. For example, the RC4195 IC provides D.C. outputs of +15v and -15v. This needs two unregulated input voltages such as the positive input may vary from +18v to +30v and negative input may vary from -18v to -30v.

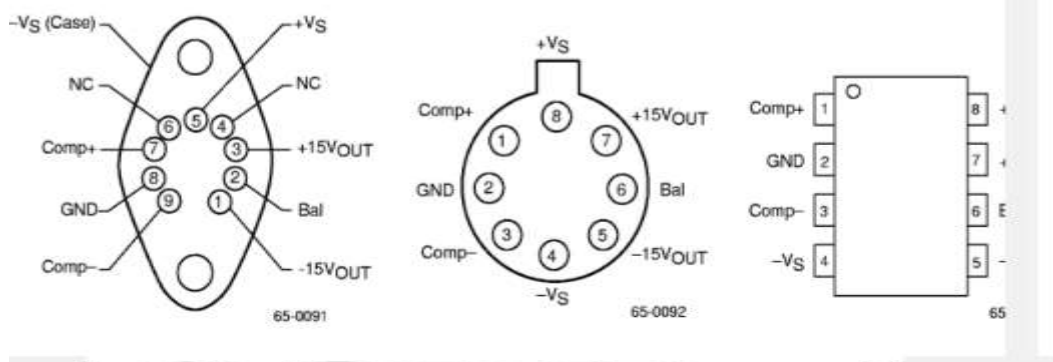
**General Description:** - The RM/RC4195 is a dual polarity tracking regulator designed to provide balanced positive and negative 15V output voltages at currents up to 100mA. This device is designed for local "on-card" regulation, eliminating distribution problems associated with single point regulation. The regulator is intended for ease of application.

**Specification: -**

- +/- 15 V operational amplifier power at reduced cost and component density
- Thermal shutdown at  $T_J=175^{\circ}\text{C}$  in addition to short circuit protection
- Output currents to 100mA
- May be used as single output regulator with up to output
- Available in TO-66 -TO-99 AND 8-LEAD MINI DIP

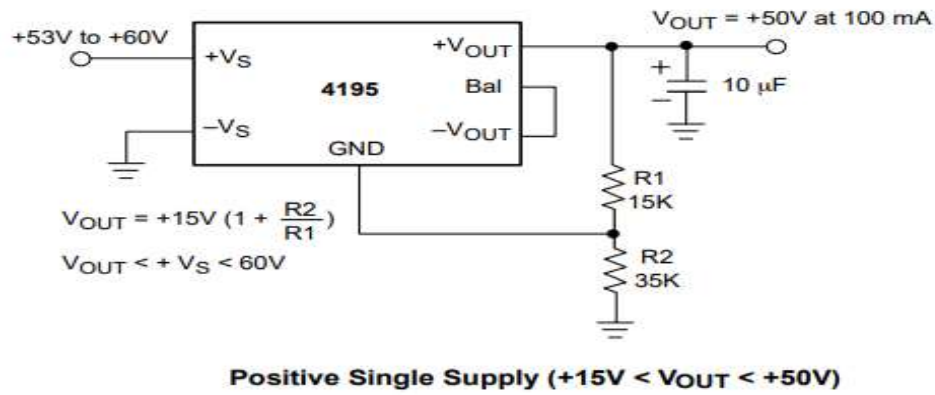
**Pinout Diagram: -**

**Pin Assignments**

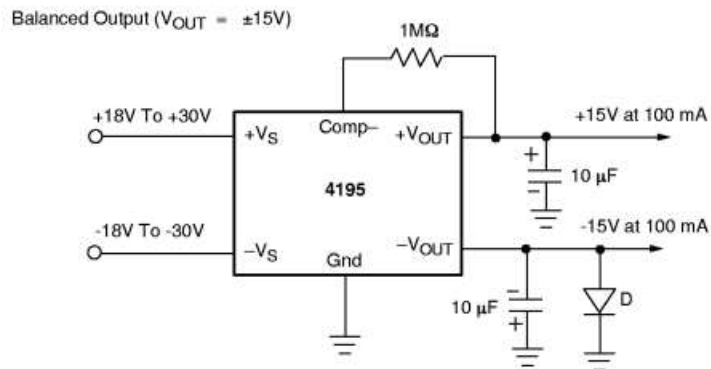


## Application Diagram: -

1. +50VOLT AT 100ma generation using RC4195



2. Dual input and output application circuit: -
- 3.



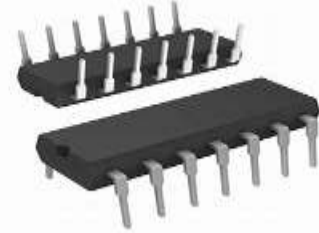
**Manufacturers** - UTC, FAIRCHILD, TAITRON, TI1, CYSTEKEC, NSC, TGS, THINKISEMI, FS, ISC, TENPOWER, COMSET, ETC, CDIL, ARTSCHIP, TI, FCI.



### III. TYPES OF IC PACKAGING

Voltage regulators IC packaging indicates the dimension and shape of a chip. Chips with the same electronic parameters may have different IC packages. Ic packages types are mainly divided into traditional DIP dual in line and SMD chip package, they are soldered by different methods.

A. **DIP (DOUBLE IN-LINE PACKAGE):** - In microelectronics, a dual in-line package is an electronic component package with a rectangular housing and two parallel rows of electrical connecting pins. Its application includes standard logic ics, memory Isis and microcomputer circuits.



B. **Sop/soic/so (small outline package):** - a small outline integrated circuit (soic) is a surface -mounted integrated circuit(ic) package which occupies an area about 30-50% less than an equivalent dual in line package with a typical thickness being 70% less. For example, a 14-pin 4011 would be housed in a soic -14 or so-14 package. Types of **SOP:** -

- SOJ- SMALL OUT-LINE J-LEADED PACKAGE
- TSOP- THIN SMALL OUTLINE PACKAGE
- SSOP- SHRINK SMALL OUTLINE PACKAGE
- TSSOP- THIN SHRINK SMALL OUTLINE PACKAGE
- QSOP – QUARTER-SIZE SMALL OUTLINE PACKAGE
- VSOP- VERY SMALL OUTLINE PACKAGE



C. **QFP: - (QUAD FLAT PACKAGE):** - IT HAS VARIENTS:

- LQFP- FLAT QUAD FLAT PACK
- TQFP- THIN QUAD FLAT PACK
- CQFP- CERAMIC QUARE FLAT PACKAGE
- BQFP- QUAD FLAT PACKAGE WITH BUMPER



D. **QFN/LCC (QUAD FLAT NON-LEADED PACKAGE)**

E. **BGA (BALL GRID ARRAY PACKAGE)**

F. **CSP (CHIP SCALE PACKAGE)**

<b>VOLTAGE REGULATOR IC'S</b>	<b>INPUT VOLTAGE RANGE</b>	<b>OUTPUT VOLTAGE RANGE</b>	<b>OUTPUT CURRENT VOLTAGE</b>	<b>MODEL NOS</b>
<b>7805</b>	7V-35 VOLT	4.8V-5.2V (REGULATED OUTPUT 5V)	Up to 1.5A	L7805CV(STMicro), LM7805(TI), MC7805CT(FAIRCHILD)
<b>7809</b>	11V-35 VOLT	9V (FIXED)	UP TO 1.5A	L7805CV(STMicro), LM7805(TI), MC7805CT(FAIRCHILD)
<b>7812</b>	14V-35V	12VOLT(FIXED)	UP TO 2.2A	L7805CV(STMicro), LM7805(TI), MC7805CT(FAIRCHILD)
<b>7824</b>	30V-34V	24VOLT (FIXED)	UP TO 1A	L7805CV(STMicro), LM7805(TI), MC7805CT(FAIRCHILD)
<b>1117</b>	20V(MAX)	1.8V,2.5V,3.3V OR 5V(FIXED)  1.25V- 13.8V(VARIABLE)	800mA	TLV1117(TI), NCV1117(NEWARK), NCP117(ROCHESTER ELECTRONICS)
<b>317</b>	4.25V-40V	1.25V to 37V(VARIABLE)	<1.5A	LM317T(TI)
<b>2596</b>	4.5V-40V	1.25V to 30V(VARIABLE)	UPTO 3A	LM2596-5.0(TI) LM2596-3.3(TI)
<b>2496</b>	4.5V TO 40V	1.2V TO 37V(VARIABLE)	UPTO 3A	MP2496(MONLITHIC POWER SYSTEM)
<b>2576</b>	UP TO 40V OR 60V	1.23V- 37V(VARIABLE)	3A(MAX)	LM2576(NATIONAL SEMICONDUCTOR)
<b>RC4195</b>	+18VOLT- +30V(VARIABLE) AND ( -18VOLT) - ( -30V) (VARIABLE)	+15V AND -15 VOLT (FIXED)	100mA	RC4195T(FAIRCHILD SEMICONDUCTOR),