AB32
Transistor Series
Voltage Regulator

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

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Transistor Series Voltage Regulator
AB32

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RoHS Compliance

Scientech Products are RoHS Complied.

RoHS Directive concerns with the restrictive use of Hazardous substances (Pb, Cd, Cr, Hg, Br compounds) in electric and electronic equipments.

Scientech products are “Lead Free” and “Environment Friendly”.

It is mandatory that service engineers use lead free solder wire and use the soldering irons upto (25 W) that reach a temperature of 450°C at the tip as the melting temperature of the unleaded solder is higher than the leaded solder.

Introduction

AB32 is a compact, ready to use **Transistor Series Voltage Regulator** experiment board. This is useful for students to study the operation of Transistor as a voltage regulator when it is connected in series. It can be used as stand alone unit with external DC power supply or can be used with **Scientech Analog Lab ST2612** which has built in DC power supply, AC power supply, function generator, modulation generator, continuity tester, toggle switches, and potentiometer.

List of Boards :

Model	**Name**
AB01	Diode characteristics (Si, Zener, LED)
AB02	Transistor characteristics (CB NPN)
AB03	Transistor characteristics (CB PNP)
AB04	Transistor characteristics (CE NPN)
AB05	Transistor characteristics (CE PNP)
AB06	Transistor characteristics (CC NPN)
AB07	Transistor characteristics (CC PNP)
AB08	FET characteristics
AB09	Rectifier Circuits
AB10	Wheatstone Bridge
AB11	Maxwell's Bridge
AB12	De Sauty's Bridge
AB13	Schering Bridge
AB15	Common Emitter Amplifier
AB14	Darlington Pair
AB16	Common Collector Amplifier
AB17	Common Base Amplifier
AB18	Cascode Amplifier
AB19	RC-Coupled Amplifier
AB20	Direct Coupled Amplifier
AB21	Class A Amplifier
AB22	Class B Amplifier (push pull emitter follower)
AB23	Class C Tuned Amplifier
AB25	Phase Locked Loop (FM Demodulator & Frequency Divider / Multiplier)
AB28	Multivibrator (Mono stable / Astable)
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB31	Zener Voltage Regulator
AB33	Transistor Shunt Voltage Regulator
AB35	DC Ammeter
AB39	Instrumentation Amplifier
AB41	Differential Amplifier (Transistorized)
AB42	Operational Amplifier (Inverting / Non-inverting / Differentiator)
AB43	Operational Amplifier (Adder/Scalar)

AB44	Operational Amplifier (Integrator/ Differentiator)
AB45	Schmitt Trigger and Comparator
AB49	K Derived Filter
AB51	Active filters (Low Pass and High Pass)
AB52	Active Band Pass Filter
AB54	Tschebyscheff Filter
AB56	Fiber Optic Analog Link
AB57	Owen's Bridge
AB58	Anderson's Bridge
AB59	Maxwell's Inductance Bridge
AB64	RC – Coupled Amplifier with Feedback
AB65	Phase Shift Oscillator
AB66	Wien Bridge Oscillators
AB67	Colpitt Oscillator
AB68	Hartley Oscillator
AB80	RLC Series and RLC Parallel Resonance
AB82	Thevenin's and Maximum power Transfer Theorem
AB83	Reciprocity and Superposition Theorem
AB84	Tellegen's Theorem
AB85	Norton's theorem
AB88	Diode Clipper
AB89	Diode Clampers
AB90	Two port network parameter
AB91	Optical Transducer (Photovoltaic cell)
AB92	Optical Transducer (Photoconductive cell/LDR)
AB93	Optical Transducer (Phototransistor)
AB96	Temperature Transducer (RTD & IC335)
AB97	Temperature Transducer (Thermocouple)
AB101	DSB Modulator and Demodulator
AB102	SSB Modulator and Demodulator
AB106	FM Modulator and Demodulator

………… and many more

Theory

Circuits that maintain power supply voltages or current output within specified limits, or tolerances are called *Regulators*. They are designated as DC voltage or DC current regulators, depending on their specific application.

Voltage regulator circuits are additions to basic power supply circuits, which are made up of rectifier and filter sections (figure 1). The purpose of the voltage regulator is to provide an output voltage with little or no variation. Regulator circuits sense changes in output voltages and compensate for the changes.

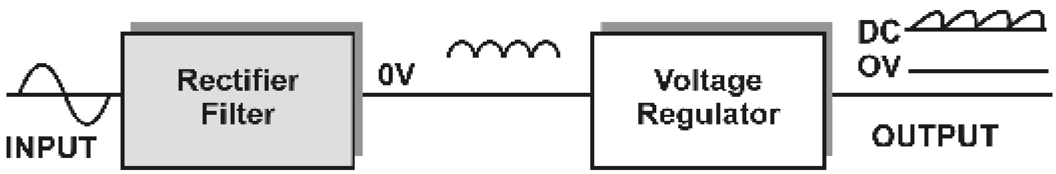


Figure 1

There are two types of voltage regulators. Basic voltage regulators are classified as either *Series* or *Shunt*, depending on the location or position of the regulating element(s) in relation to the circuit load resistance. Figure 2 illustrates these two basic types of voltage regulators. Broken lines have been used in the figure to highlight the difference between the series and shunt regulators.

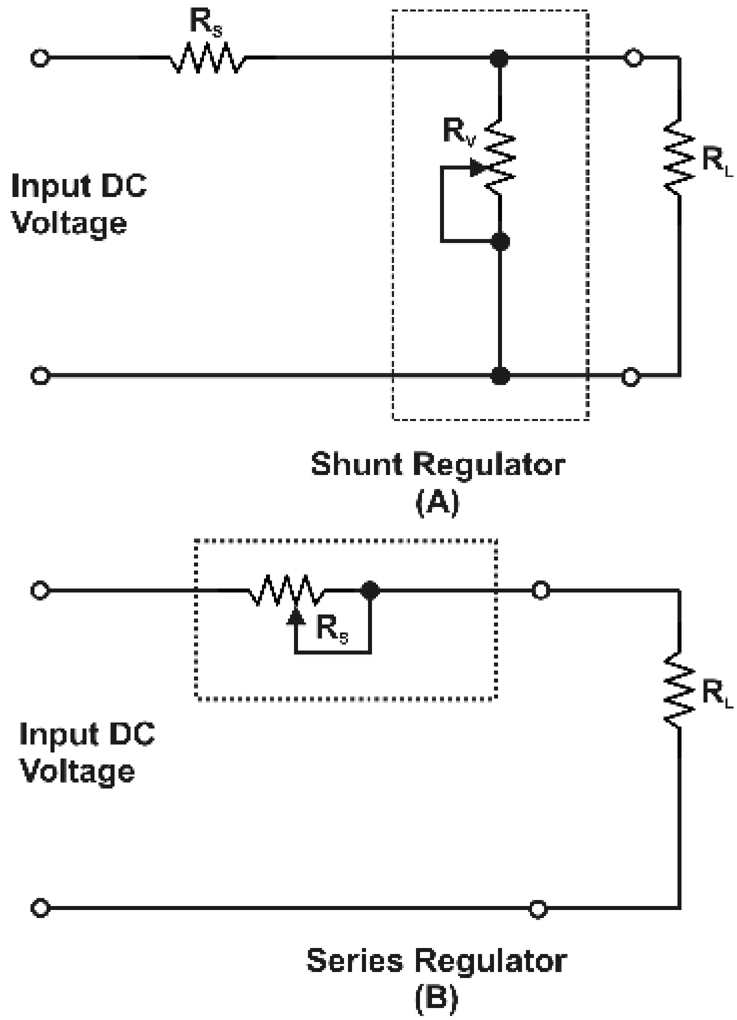


Figure 2

The schematic drawing in view B is that of a series regulator. It is called series regulator because the regulating device is connected in series with the load resistance. Figure 2 illustrates the principle of series voltage regulation. From the figure it is clear that the regulator is in series with the load resistance (R_L) and that the fixed resistor (R_S) is in series with the load resistance. You already know the voltage drop across affixed resistor remains constant unless the current flowing through it varies (increases or decreases).

The schematic for a typical series voltage regulator is shown in figure 3. Notice that this regulator has a NPN transistor 2N3904 in place of the variable resistor found in figure 2.

Because the total load current passes through this transistor, it is sometimes called a ‘‘pass transistor’’. Other components, which make up the circuit, are the current limiting resistor of 200Ω and the Zener diode of 5.6V

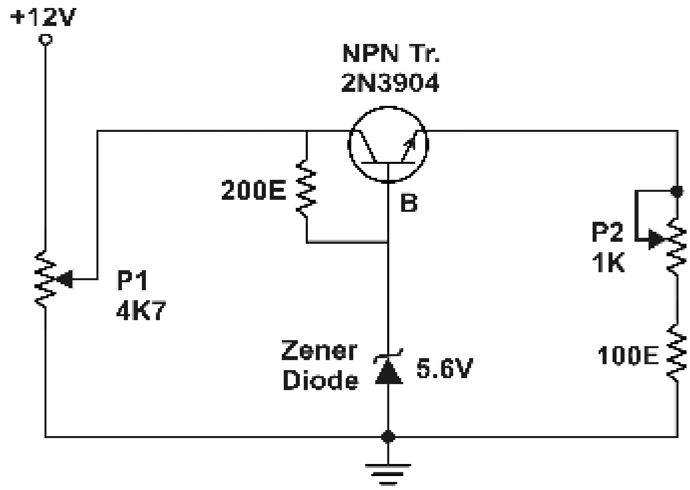


Figure 3

Recall that a Zener diode is a diode that block current until a specified voltage is applied. Remember also that the applied voltage is called Breakdown, or Zener voltage. When the Zener voltage is reached, the Zener diode conducts from its anode to its cathode (with the direction of the arrow).

In this voltage regulator, Transistor has a constant voltage applied to its base. This voltage is often called the reference voltage. As the change in the circuit output voltage occur, they are sensed at the emitter of the transistor producing a corresponding change in the forward bias of the transistor. In other words, transistor compensates by increasing or decreasing its resistance in order to change the circuit voltage division.

Circuit Operation :

Case 1 : When input voltage is constant while Load varies.

Here NPN Transistor used in series controls the amount of the input voltage that gets to the output and zener diode provides the reference voltage. The zener establishes the value of the base voltage for transistor. Keep in mind the polarities of different voltages, they are related by the equation

$$V_L + V_{BE} - V z = 0 \quad \text{Kirchoff's voltage law}$$

Therefore $V_{BE} = V_Z - V_L$ Here V_Z is fixed

The output voltage across load will be equal to the zener voltage minus 0.7Volt drop across the forward biased Base-Emitter Junction of transistor, or 4.9V (5.6 – 0.7).

When current demand is increased by decreasing R_L, V_L tends to decrease. It will increase V_{BE} because V_Z is fixed. This will increase forward bias of the transistor thereby increasing its level of conduction. This will lead to decrease in the collector-emitter resistance of the transistor which will slightly increase the input current to compensate for decrease in R_L so that $V_L = I_L R_L$ will remain at constant value.

Case 2 : When input voltage varies while Load remains constant.

When the input voltage increases, output voltage across increases momentarily. This momentarily deviation or variation, from the required regulated output voltage of 4.9 volts is a result of a rise in the input voltage. Since the base voltage of transistor is held at 5.6V by zener, that's why the forward bias of transistor decreases. Because this bias voltage is less than the normal 0.7 volts, the resistance of transistor increases, thereby increasing the voltage drop across the transistor.

This voltage drop restores the output voltage to the required regulated voltage of 4.9V.

Note :

1. Regulated output voltage might be slightly higher than the expected voltage due to tolerance of Zener diode.

Experiment 1

Objective :

Study of Transistor Series Voltage Regulator, when Input Voltage V_{in} is fixed while Load resistance R_L is variable.

Equipments Needed :

1. Analog board of **AB32.**
2. DC power supply +12V external source or **ST2612 Analog Lab**.
3. Digital Multimeters (2 numbers).
4. 2 mm patch cords.

Circuit diagram :

Circuit used to study Transistor Series Voltage Regulator is shown in figure 4.

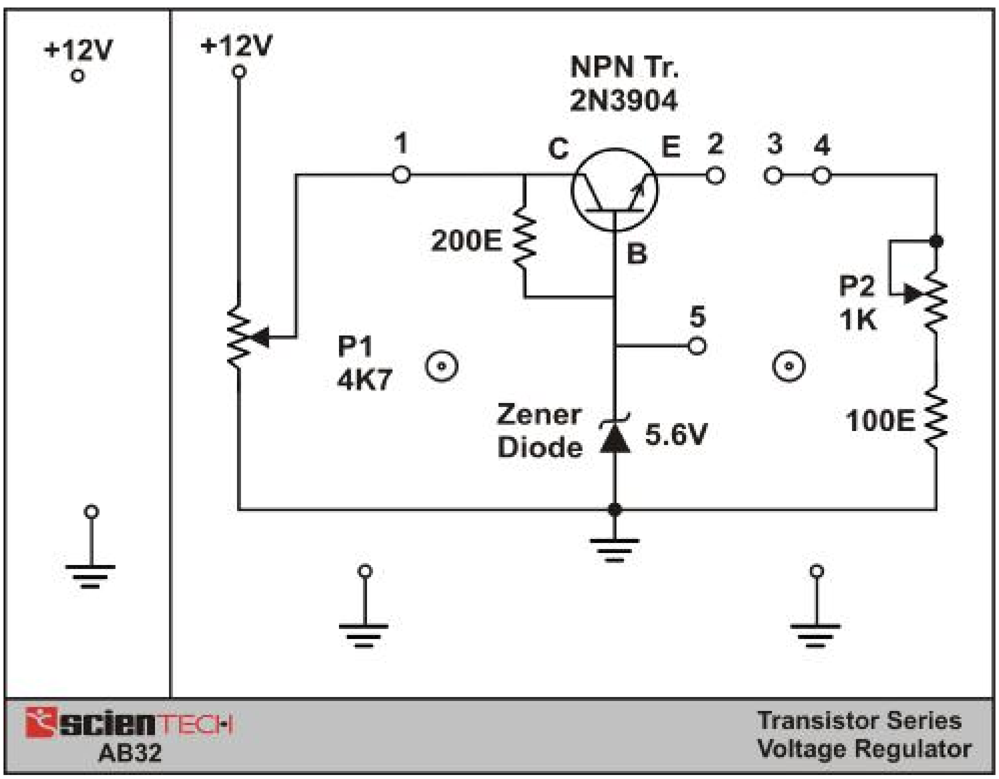


Figure 4

Procedure :

- Connect + 12V DC power supply at their indicated position from external source or **ST2612 Analog Lab**.

1. Connect one voltmeter between test point 1 and ground to measure input voltage V_{in}.

2. Connect ohmmeter between test point 4 and ground and set the value of load resistance R_L at some fixed value [full load (1.1K), 1K, 500Ω...]

3. Connect a 2mm patch cord between test point 2 and 3.

4. Connect voltmeter between test point 4 and ground to measure output voltage V_{out}.

5. Switch on the power supply.

6. Vary the potentiometer P_1 to set fixed value of input voltage Vin = 9V and measure the corresponding values of

   a. Output voltage V_{out} between test points 4 and ground.

   b. Zener voltage V_Z between test points 5 and ground.

   c. Forward bias voltage V_{BE} of transistor between test point 5 and 4.

7. Disconnect the 2mm patch cord between test point 2 and 3.

8. Repeat the procedure from step 3 for different sets of load resistance R_L and note the results in an observation Table 1.

Observation Table 1 :

Sr. No.	**Load Resistance R_L**	**Voltage Across Zener V_Z**	**Forward bias voltage V_{BE}**	**Output voltage V_{out} at constant Input voltage V_{in} = 9 volt**
1.	Full Load (1.1K)			
2.	1K Ω			
3.	800 Ω			
4.	600 Ω			
5.	400 Ω			
6.	200 Ω			
7.	No Load			

Note : To measure Voltage at No Load disconnect 2mm patch cord between test point 2 and 3, measure voltage between test point 2 and ground.

Calculations :

Percentage Regulation is given by formula

$$\% \text{ Regulation} = [(V_{NL} - V_{FL}) / V_{FL}] * 100$$

Where,
R = resistance in series
V_{NL} = no-load or open-circuit terminal voltage.
V_{FL} = full-load terminal voltage.

Results :

1. The result of Experiment 1 reveal that for the network of figure 4 with a fixed input voltage V_{in} the output voltage will remain close to 4.9 V for a range of load resistance that extends from ______ to _______ .

2. Percentage regulation = _______%

Experiment 2

Objective :

Study Transistor Series Voltage Regulator, when Input Voltage V_{in} is variable while Load Resistance R_L is fixed.

Equipments Needed :

1. Analog board of **AB32.**
2. DC power supply +12V external source or **ST2612 Analog Lab**.
3. Digital Multimeters (2 numbers).
4. 2 mm patch cords.

Circuit diagram :

Circuit used to study Transistor Series Voltage Regulator is shown in figure 5.

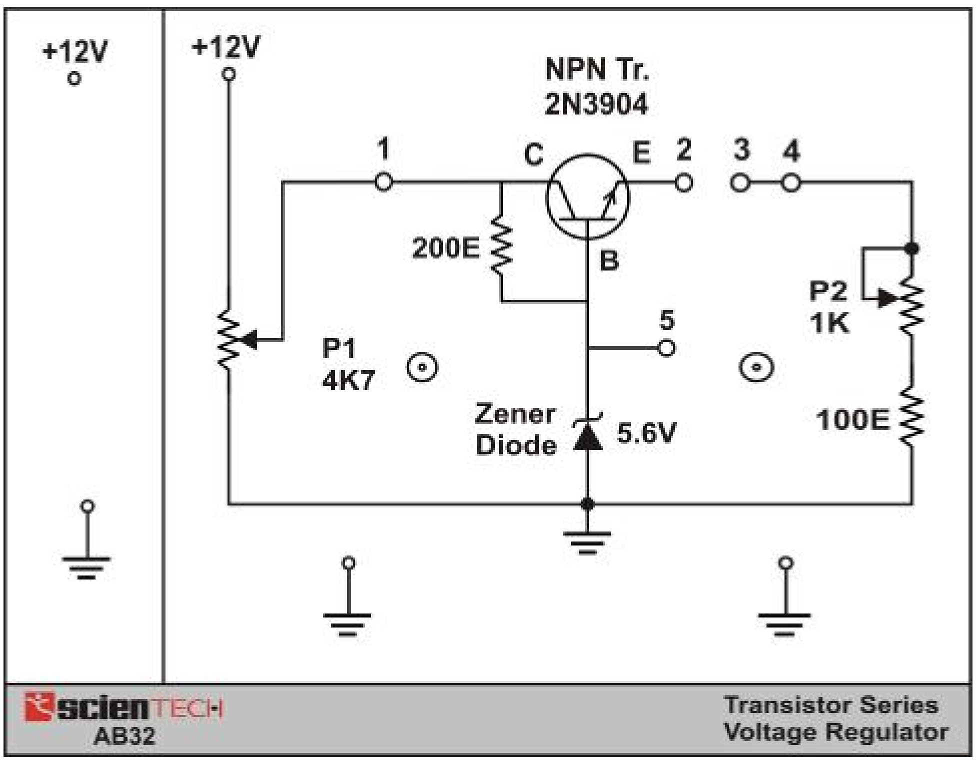


Figure 5

Procedure :

- Connect +12V DC power supply at their indicated position from external source or **ST2612 Analog Lab**.

1. Connect one voltmeter between test point 1 and ground to measure input voltage $V_{in.}$

2. Connect ohmmeter between test point 4 and ground and set the value of load resistance R_L at maximum value.

3. Connect a 2mm patch cord between test point 2 and 3.

4. Connect voltmeter between test point 4 and ground to measure output voltage V_{out}.

5. Switch on the power supply.

6. Vary the potentiometer P_1 to set fixed value of input voltage V_{in} = 7V, 8V, 9V… and measure the corresponding values of

   a. Output voltage V_{out} between test points 4 and ground.

   b. Zener voltage V_z between test points 5 and ground.

   c. Forward bias voltage V_{BE} of transistor between test point 5 and 4.

7. Repeat the procedure from step 7 for different sets of input voltage V_{in} and note the results in an Observation Table 2.

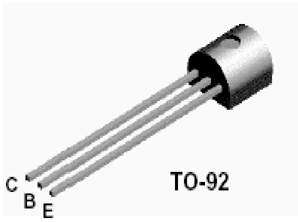
Observation Table 2 :

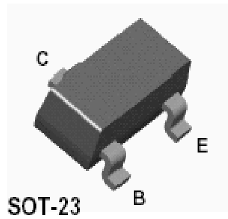
Sr. No.	Input Voltage V_{in}	Voltage Across Zener V_Z	Forward bias voltage V_{BE}	Output voltage V_{out} at fixed load resistance R_L = Max
1.	7 V			
2.	8 V			
3.	9 V			
4.	10 V			
5.	11 V			

Results :

1. The result of Experiment 2 reveal that for the network of figure 5 with a fixed Load resistance, the output voltage will remain close to 4.9V for a range of input voltage V_{in} that extends from _____ to_____ .

Data Sheet





SOT-23
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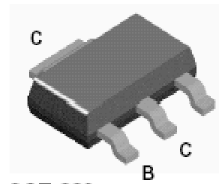

SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at collector currents of 10 µA to 100 mA.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3) All voltages (V) and currents (A) are negative polarity for PNP transistors.

Warranty

1. We guarantee the product against all manufacturing defects for 24 months from the date of sale by us or through our dealers. Consumables like dry cell etc. are not covered under warranty.
2. The guarantee will become void, if
   a) The product is not operated as per the instruction given in the operating manual.
   b) The agreed payment terms and other conditions of sale are not followed.
   c) The customer resells the instrument to another party.
   d) Any attempt is made to service and modify the instrument.
3. The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.
4. The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

For any Technical Problem Please Contact us at **service@scientech.bz**

List of Accessories

1. 2mm Patch Cord 16" (Red) .... 1 No.
2. 2mm Patch Cord 16" (Black) .... 1 No.
3. 2mm Patch Cord 16" (Blue) .... 1 No.
4. e-Manual .... 1 No.

Updated 26-06-2009