AB31
Zener Voltage Regulator

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

Innovative Technology Ecosystem

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TÜV Rheinland Group

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AB31
Zener Voltage Regulator

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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

AB31 is a compact, ready to use **Zener Voltage Regulator** experiment board. This is useful for students to study the operation of zener diode as a voltage regulator with the variation in source voltage and load resistance. 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
AB14	Darlington Pair
AB15	Common Emitter Amplifier
AB16	Common Collector Amplifier
AB17	Common Base Amplifier
AB18	RC-Coupled Amplifier
AB19	Cascode Amplifier
AB20	Direct Coupled Amplifier
AB21	Class A Amplifier
AB22	Class B Amplifier (push pull emitter follower)
AB23	Class C Tuned Amplifier
AB24	Transformer Coupled Amplifier
AB25	Phase Locked Loop (FM Demodulator & Frequency Divider / Multiplier)
AB26	FET Amplifier
AB27	Voltage Controlled Oscillator
AB28	Multivibrator (Mono stable/Astable)
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB32	Transistor Series Voltage Regulator
AB33	Transistor Shunt Voltage Regulator
AB35	DC Ammeter
AB37	DC Ammeter (0-2mA)

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
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

Voltage regulation is a measure of a circuit's ability to maintain a constant output voltage even when either input voltage or load current varies, A zener diode, when working in the break down region, can serve as a voltage regulator. In figure 1, V_{in} is the input voltage whose variations are to be regulated. The load resistance, across which a constant voltage V_{out} is required, is connected in parallel with the Zener diode. When potential difference across the diode is greater than V_Z, it conducts and draws relatively large current through the series resistance R. The total current I passing through R equals the sum of diode current and load current i.e.,

$$I = I_Z + I_L.$$

It will be seen that under all conditions, $V_{out} = V_Z$.

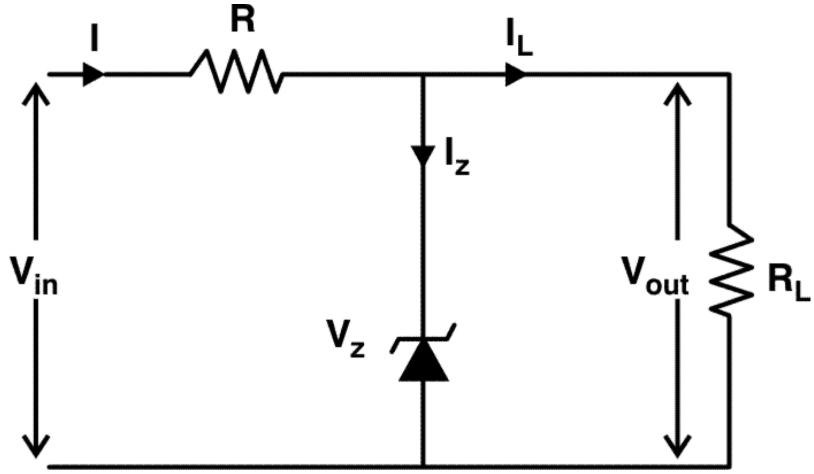

Figure 1

Case 1 : Fixed input voltage V_{in} and variable Load resistance R_L.

In this case V_{in} is fixed but R_L hence I_L is changed. When I_L increases, diode current I_Z decreases thereby keeping I and hence IR drop constant. In this way V_{out} remains unaffected. When I_L decreases, diode current I_Z increases thereby keeping I and hence IR drop constant. In this way again V_{out} remains unchanged.

Due to the offset voltage Vz, there is a specific range of resistor values (and therefore load current) which will ensure that the Zener is in the 'on' state. Too small a load resistance R_L will result in a voltage V_L across the load resistor less than V_Z and the Zener device will be in the 'off' state.

To determine the minimum load resistance that will turn the Zener diode 'on' is given by

$$R_{Lmin} = RVz / (V_{in} – V_Z)$$

Any load resistance value greater than the R_L obtained from above equation will ensure that the zener diode is in the ‘on’ state and the diode can be replaced by its V_Z source equivalent.

Similarly maximum load resistance is given by

$$R_{Lmax} = V_Z / I_{Lmin}$$

Where

$$I_{Lmin} = I_R - I_{ZM}$$

$$I_R = V_R / R,$$

$$V_R = V_{in} - V_Z$$

Case 2 : Variable input voltage Vi and fixed load resistance R_L.

In this case, when input voltage V_{in} is increased slightly keeping load resistance R_L constant. It will increase I. This increase in I will be absorbed by the Zener diode without affecting I_L. This increase in V_{in} will be dropped across R thereby keeping V_{out} constant.

Conversely, if supply voltage V_{in} falls, the diode takes a smaller current and voltage drop across R is reduced, thus again keeping V_{out} constant.

Hence, when V_{in} changes, I and I_R drop change in such a way as to keep V_{out} (= V_Z) constant.

For fixed value of R_L, the voltage V_{in} must be sufficiently large to turn the Zener diode ‘‘on’’. The minimum turn-on voltage $V_{i(min)}$ is determined by

$$V_{i(min)} = (R_L + R)V_Z / R_L$$

The maximum value of V_i is limited by the maximum Zener current I_{ZM}. Since

$$I_{ZM} = I_R - I_L, I_{Rmax} = I_{ZM} + I_L$$

Since I_L if fixed at V_Z/R_L and I_{ZM} is the maximum value of Iz, the maximum V_{in} is defined by

$$V_{i(max)} = I_{Rmax} R + V z$$

Note :

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

2. A series resistor of 33 ohms is connected internally with potentiometer P1, for over current protection thus the maximum voltage that you can get at test point I is about 9.5V

Experiment 1

Objective :

Study of Zener diode as a voltage regulator, when input voltage V_{IN} is fixed while Load resistance R_L is variable

Equipments Needed :

1. Analog board of **AB31.**
2. DC Power Supply +12V external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).
4. 2 mm patch cords.

Circuit diagram :

Circuit used to study Zener diode as a voltage regulator is shown in figure2.

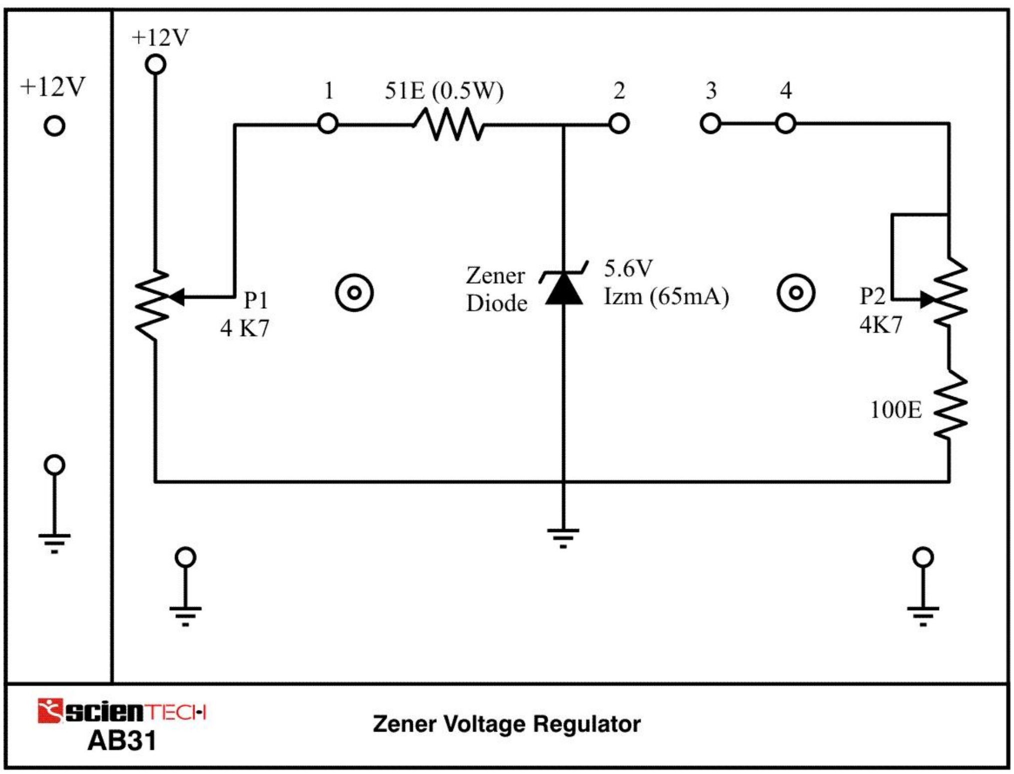

Figure 2

Procedure :

1. Connect + 12V DC Power Supply at their indicated position from external source or **ST2612 Analog Lab**.
2. Connect one voltmeter between test point 1 and ground to measure input voltage V_{in}.
3. Connect ohmmeter between test point 4 and ground and set the value of load resistance R_L at some fixed value (500Ω, 600Ω, ……..1K, 1.1K)
4. Connect a 2mm patch cord between test point 2 and 3.
5. Connect voltmeter between test point 4 and ground to measure output voltage V_{out}.
6. Switch on the Power Supply.
7. Vary the potentiometer P_1 to set fixed value of input voltage V_{in}=10V and measure the corresponding value of output voltage V_{out}.
8. Disconnect the 2mm patch cord between test point 2 and 3.
9. 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 :

S. Number	Load Resistance R_L	Output voltage V_{out}(volt) at constant Input voltage V_{in} = 9 volt
1.	100 Ω	
2.	200 Ω	
3.	300 Ω	
4.	400 Ω	
5.	500 Ω	
6.	600 Ω	
7.	700 Ω	
8.	800 Ω	
9	900 Ω	
10.	1.0 K	
11.	2.0 K	
12.	3.0 K	

Calculations :

Determine the range of load resistance for case second i.e. when input voltage is fixed while the load resistance is variable, by using formula, Minimum load resistance

$$R_{Lmin} = RV_z / (V_{in} - V_z)$$

Where

R is the resistance in series, V_z is the Zener breakdown voltage V_{in} is the fixed input voltage applied

In the circuits used Vz = 5.6V, R = 51Ω, V_{in} = 10V

Maximum load resistance

$$R_{Lmax} = Vz / I_{Lmin}$$

where

$$I_{Lmin} = I_R - I_{ZM},\ I_R = V_R / R,\ V_R = V_{in} - V_Z$$

In the circuit used Vz = 5.6V, R = 51Ω, I_{ZM} = 65mA

Results :

1. Theoretical the range of Load resistance obtained is

R_{Lmin} = ____________

R_{Lmax} = ____________

2. The result of Experiment 2 reveal that for the network of figure 2 with a fixed input voltage V_{in} the output voltage will remain fixed at 5.6 V for a range of load resistance that extends from _______ to _______.

Experiment 2

Objective :

Study of Zener diode as a voltage regulator, when input voltage V_{IN} is variable while Load resistance R_L is fixed

Equipment Needed :

1. Analog board of **AB31.**
2. DC Power Supply +12V external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).
4. 2 mm patch cords.

Circuit diagram :

Circuit used to study Zener diode as a voltage regulator is shown in figure3.

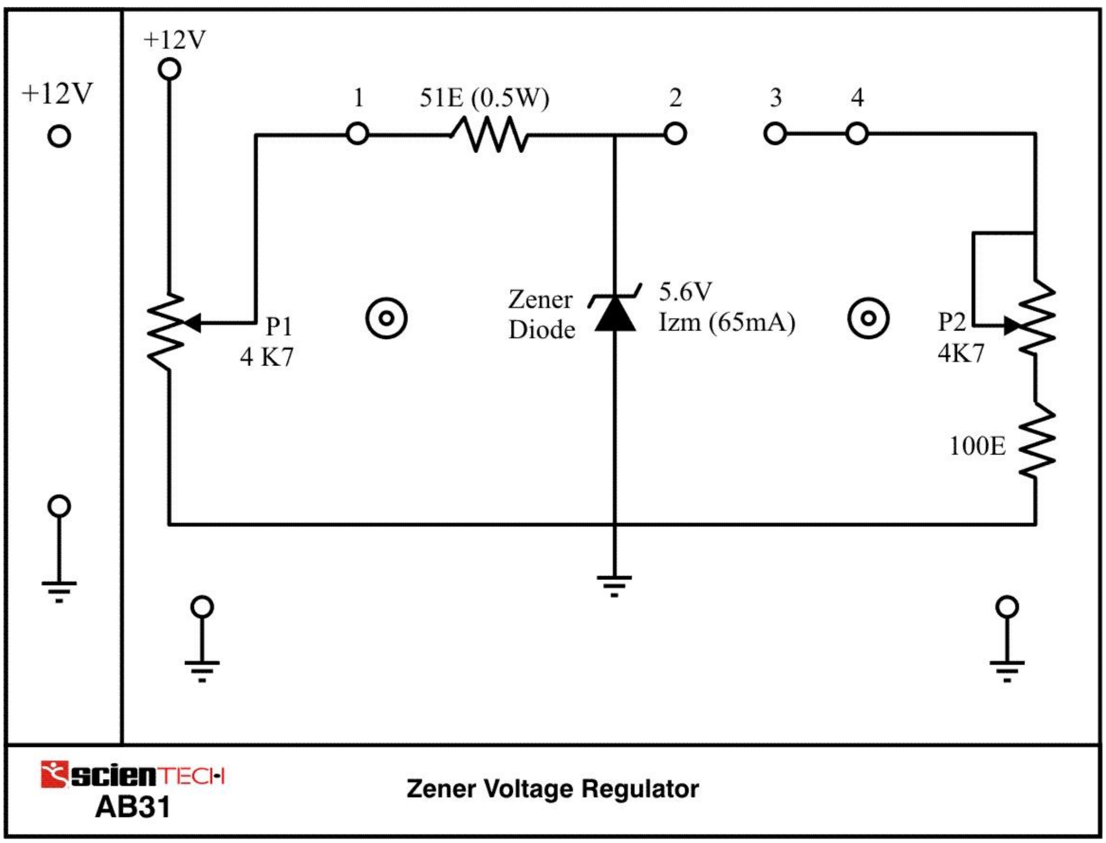

Figure 3

Procedure :

1. Connect + 12V DC Power Supply at their indicated position from external source or **ST2612 Analog Lab**.
2. Connect one voltmeter between test point 1 and ground to measure input voltage V_{in}.
3. Connect ohmmeter between test point 4 and ground and set the value of load resistance R_L at a fixed value of 1 K.
4. Connect a 2mm patch cord between test point 2 and 3.
5. Connect voltmeter between test point 4 and ground to measure output voltage V_{out}.
6. Switch on the Power Supply.
7. Vary the potentiometer P_1 to some fixed value of input voltage V_{in} = (6V, 7V……) and measure the corresponding value of output voltage V_{out}.
8. Repeat the above step and note the results in an observation Table 2.

Observation Table 2 :

S. Number	Input voltage V_{in}	Output voltage V_{out} (volt) at constant Load resistance = 1 K
1.	6.0 V	
2.	6.5 V	
3.	7.0 V	
4.	7.5 V	
5.	8.0 V	
6.	8.5 V	
7.	9.0 V	
8.	9.5 V	

Calculations :

Determine the range of input voltage when load resistance is fixed while the input voltage is variable, by using formula, Minimum turn-on voltage $V_{i\ (min)}$ is

$$V_{i\ (min)} = (R_L + R)\ V_Z / R_L$$

Where
R_L is the fixed value of load resistance
R is the series resistance
V_Z is the Zener breakdown voltage

In the circuit used R_L = l K, R = 51Ω, V_z = 5.6 V

Maximum value of input voltage $V_{i\ (max)}$ is given by

$$Vi\ (max) = I_{Rmax}R + Vz$$

Where

$$I_{Rmax} = I_{ZM} + I_L$$

$$I_{ZM} = I_R - I_L,$$

$$I_L = V_Z / R_L$$

In the circuit used V_Z = 5.6V, R = 51Ω, I_{ZM} = 65mA, RL = 1K

Results :

1. Theoretical the range of input voltage obtained is

$V_{i(min)}$ = _______________

$V_{i(max)}$ = ________________

2. The result of Experiment 3 reveal that for the network of figure 3 with a fixed load resistance R_L, the output voltage will remain fixed at 5.6 V for a range of input voltage that extends from ___________ to______________.

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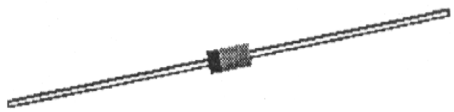
Data Sheet

SILICON ZENER DIODES

1N746 to 1N759
DO-35 400mW



Hermetically Sealed Glass Package Zener Diodes

ABSOLUTE MAXIMUM RATINGS

DESCRIPTION	SYMBOL	VALUE	UNIT
Zener Voltage	ZV	3.3 to 12	V
D C Power Dissipation	PD	400	mW
Derating Above 50 deg C		3.2	mW/deg C
Operating & Storage Junction Temperature Range	Tj,Tstg	-65 to +175	deg C

ELECTRICAL CHARACTERISTICS (Ta=25 deg C Unless otherwise Specified , VF <1.5V @ 200mA

Device Type# (1)	Nominal* Zener Voltage VZ @ IZT (V)	Zener Test Current IZT (mA)	Maximum Zener Impedance Zzt @ IZT (Ohms)	Maximum Reverse Current @25 deg C max (uA)	@ @ +150 deg C max (uA)	VR (V)	Maximum Zener Current IZM (mA)	Typ Temp Coeff of Zener Voltage *vz (% deg C)
1N746	3.3	20	28	10	30	1.0	110	-0.066
1N747	3.6	20	24	10	30	1.0	100	-0.058
1N748	3.9	20	23	10	30	1.0	95	-0.046
1N749	4.3	20	22	2.0	30	1.0	85	-0.033
1N750	4.7	20	19	2.0	30	1.0	75	-0.015
1N751	5.1	20	17	1.0	20	1.0	70	+-0.010
1N752	5.6	20	11	1.0	20	1.0	65	+0.030
1N753	6.2	20	7	0.1	20	1.0	60	+0.049
1N754	6.8	20	5	0.1	20	1.0	55	+0.053
1N755	7.5	20	6	0.1	20	1.0	50	+0.057
1N756	8.2	20	8	0.1	20	1.0	45	+0.060
1N757	9.1	20	10	0.1	20	1.0	40	+0.061
1N758	10	20	17	0.1	20	1.0	35	+0.062
1N759	12	20	30	0.1	20	1.0	30	+0.062

Note(1) :- No Suffix +-10%
Suffix A +- 5%

* Pulse Condition : 20ms <tp 50ms, Duty Cycle<2%

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

Updated 25-03-2009