AB01
Silicon, Zener, LED
Diode Characteristics

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

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TÜV Rheinland Group

CERTIFICATE

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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

AB0l is a compact, ready to use **Diode Characteristics** experiment board. This is useful for students to plot V-I characteristics of Si Diode, Zener Diode, and light Emitting Diode in forward as well as in reverse bias region of operation. 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
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 (Monostable / Astable)
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB31	Zener Voltage Regulator
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

Introduction :

A *diode* is an electrical device allowing current to move through it in one direction with far greater ease than in the other. The most common type of diode in modem circuit design is the *semiconductor* diode, although other diode technologies exist. Semiconductor diodes are symbolized in schematic diagrams as shown below

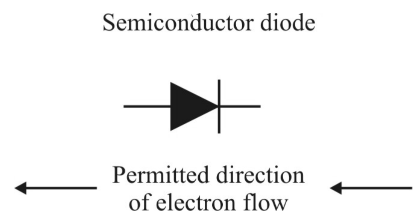


Figure 1

When placed in a simple battery-lamp circuit, the diode will either allow or prevent current through the lamp, depending on the polarity of the applied voltage:

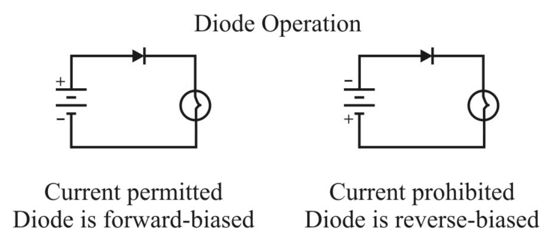


Figure 2

When the polarity of the battery is such that electrons are made to flow through the diode, the diode is said to be ***forward-biased***. Conversely, when the battery is "backward" and the diode blocks current, the diode is said to be ***reverse biased***. A diode may be thought of as a kind of switch: "closed" when forward-biased and "open" when reverse-biased.

V-I Characteristic :

The static voltage-current characteristics for a P-N Junction diode are shown in figure 3.

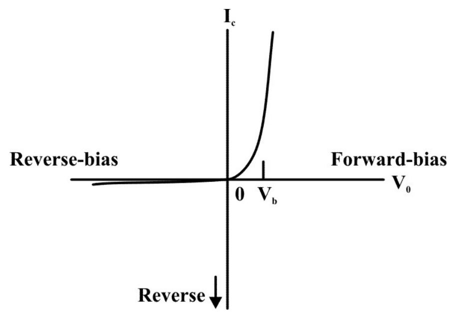


Figure 3

Forward Characteristic :

When the diode is in forward-biased and the applied voltage is increased from zero, hardly any current flows through the device in the beginning. It is so because the external voltage is being opposed by the internal barrier voltage V_B whose value is 0.7V for Si and 0.3V for Ge. As soon as V_B is neutralized, current through the diode increases rapidly with increasing applied supply voltage. It is found that as a little voltage of 1.0V produces a forward current of about 50mA.

Reverse Characteristic :

When the diode is reverse-biased, majority carrier are blocked and only a small current (due to minority carrier) flows through the diode. As the reverse voltage is increased from zero, the reverse current very quickly reaches its maximum or saturation value I_o which is also known as leakage current. It is of the order of nanoAmperes (nA) and microAmperes (μA) for Ge.

As seen from figure 3, when reverse voltage exceeds a certain value called breakdown voltage V_{BR}, the leakage current suddenly and sharply increases, the curve indicating zero resistance at this point.

Zener Diode :

It is the reverse-biased heavily-dopped silicon (or germanium) P-N Junction diode which is operated in the breakdown region where current is limited by both external resistance and power dissipation of the diode. Silicon is preferred to diode because of its higher temperature and current capability. Zener breakdown occurs due to breaking of covalent bonds by the strong electric field set up in the depletion region by the reverse voltage.

It produces an extremely large number of electrons and holes, which constitute the reverse saturation current (called zener current I_z) whose value is limited only by the external resistance in the circuit.

V-I Characteristic :

Figure 4 shows typical characteristics in the negative quadrant. The forward characteristic is simply that of an ordinary forward-biased junction diode. The important points of the reverse characteristic are V_z = Zener breakdown voltage.

$I_{z\ min}$ = Minimum current to sustain breakdown

$I_{z\ max}$ = Maximum Zener current limited by, maximum power dissipation. Since its reverse characteristic is not exactly vertical, the diode possesses some resistance called Zener dynamic impedance. Its value is given by $Z_z = \Delta V_z / \Delta I_z$.

Zener diode are available having zener voltage of 2.4V to 200V. This voltage is temperature dependent. The product V_z, I_z, gives their power dissipation. Maximum ratings vary from 150mW to 50W.

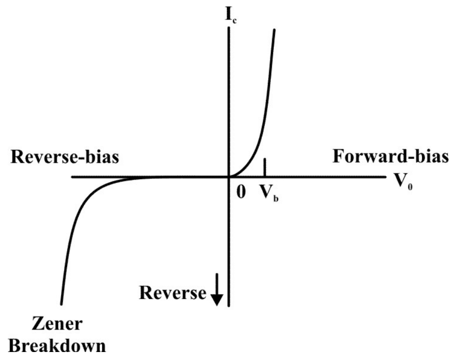


Figure 4

For proper working of a Zener diode in any circuit, it is essential that it must

1. Be reverse-biased,

2. Have voltage across it greater than V_z,

3. Be in a circuit where current is less than I_{zmax}.

Light-emitting Diodes :

Diodes, like all semiconductor devices, are governed by the principles described in quantum physics. One of these principles is the emission of specific-frequency radiant energy whenever electrons fall from a higher energy level to a lower energy level.

A diode intentionally designed to glow like a lamp is called a *light-emitting diode*, or *LED*. Diodes made from a combination of the elements gallium, arsenic, and phosphorus (called *gallium-arsenide-phosphide*) glow bright red, and one of some of the most common LED manufactured. By altering the chemical constituency of the PN junction, different colors may be obtained. Some of the currently available colors other than red are green, blue, and infra-red (invisible light at a frequency lower than red). Other colors may be obtained by combining two or more primary-color (red, green, and blue). The schematic symbol for an LED is a regular diode shape inside of a circle, with two small arrows pointing away (indicating emitted light)

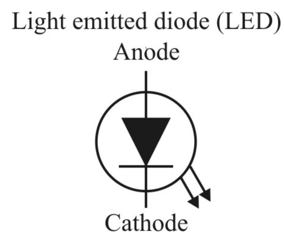
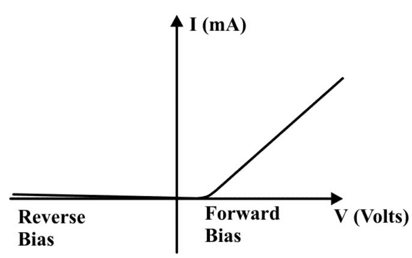


Figure 5

This notation of having two small arrows pointing away from the device is common to the schematic symbols of all light-emitting semiconductor devices. Conversely, if a device is light-*activated* (meaning that incoming light stimulates it), then the symbol will have two small arrows pointing ***toward*** it. It is interesting to note, though, that LEDs are capable of acting as light-sensing devices: they will generate a small voltage when exposed to light, much like a solar cell on a small scale. This property can be gainfully applied in a variety of light-sensing circuits.

Because LEDs are made of different chemical substances than normal rectifying diodes, their forward voltage drops will be different. Typically, LEDs have much larger forward voltage drops than rectifying diodes, anywhere from about 1.6 Volts to over 3 Volts, depending on the color. Typical operating current for a standard-sized LED is around 20 mA. When operating an LED from a DC voltage source greater than the LED's forward voltage, a series-connected "dropping" resistor must be included to prevent full source voltage from damaging the LED. LED starts emitting light as its forward voltage reaches at a particular level and its intensity will increase further with the increase in applied forward voltage. LEDs emit no light when reverse biased. In fact, operating LEDs in reverse direction will quickly destroy them if the applied voltage is quite large. LEDs V-I characteristic curve is shown in figure 6.



Characteristics of LED

Figure 6

Experiment 1

Objective :

Study of characteristics of Silicon diode in :

1. **Forward bias**
2. **Reverse bias**

Equipments Needed :

1. Analog board of **AB01.**
2. DC power supplies +12V from external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).

Circuit diagram :

Circuit used to plot different characteristics of Si diode is shown in figure 7.

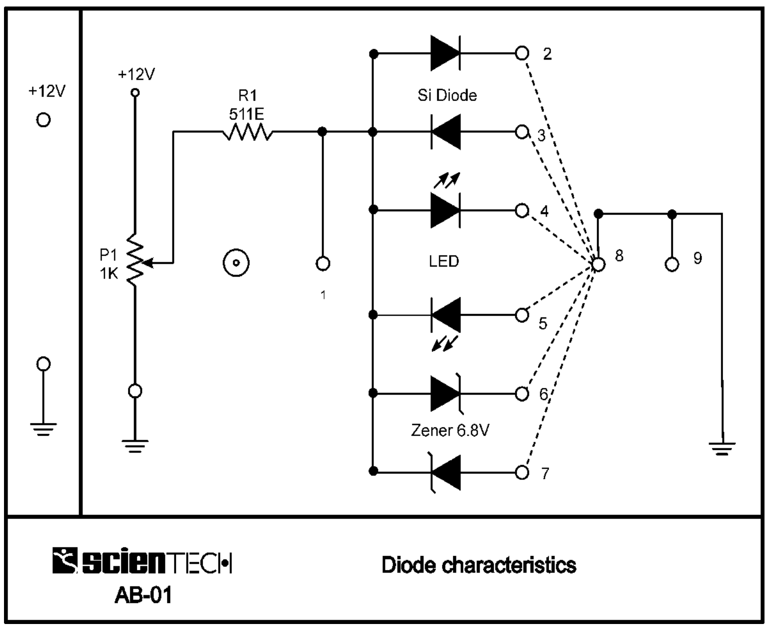


Figure 7

Procedure :

- Connect +12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.
- To plot forward characteristics proceed as follows

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).

2. Connect Ammeter between test point 2 and 8 to measure diode current I_D (mA).

3. Connect one voltmeter between test point 1 and 9 to measure voltage V_D diode

4. Switch 'On' the power supply.

5. Vary the potentiometer P_1 so as to increase the value of diode voltage V_D from zero to 1V in step and measure the corresponding values of diode current I_D in an observation Table 1.

6. Plot a curve between diode voltage V_D and diode current I_D as shown in figure 3 (First quadrant) using suitable scale with the help of observation Table 1. This curve is the required forward characteristics of Si diode.

Observation Table 1 :

S. No.	Diode Voltage (VD)	Diode current I_D (mA)
1.	0.0V	
2.	0.1V	
3.	0.2V	
4.	0.3V	
5.	0.4V	
6.	0.5V	
7.	0.6V	
8.	0.7V	
9.	0.8V	
10.	0.9V	
11.	1.0V	

- To plot Reverse characteristics of a Si diode proceed as follows

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).

2. Connect Ammeter between test point 3 and 8 to measure diode current I_D (nA).

3. Connect one voltmeter between test point 1 and 9 to measure voltage V_D diode

4. Switch 'On' the power supply.

5. Vary the potentiometer P_1 so as to increase the value of diode voltage V_D from zero to 10V in step and measure the corresponding values of diode current I_D in an observation Table 2.

6. Plot a curve between diode voltage V_D and diode current I_D as shown in figure 3 (third quadrant) using suitable scale with the help of observation Table 2. This curve is the required forward characteristics of Si diode.

Observation Table 2 :

S. No.	Diode Voltage (V_D)	Diode current I_D (nA)
1.	0.0V	
2.	1.0V	
3.	2.0V	
4.	3.0V	
5.	4.0V	
6.	5.0V	
7.	6.0V	
8.	7.0V	
9.	8.0V	
10.	9.0V	
11.	10.0V	

Experiment 2

Objective :

Study of characteristics of Zener diode in

1. **Forward bias**
2. **Reverse bias**

Equipments Needed :

1. Analog board of **AB01**
2. DC power supplies +12V from external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).

Circuit diagram :

Circuit used to plot different characteristics of Zener diode is shown in figure 8

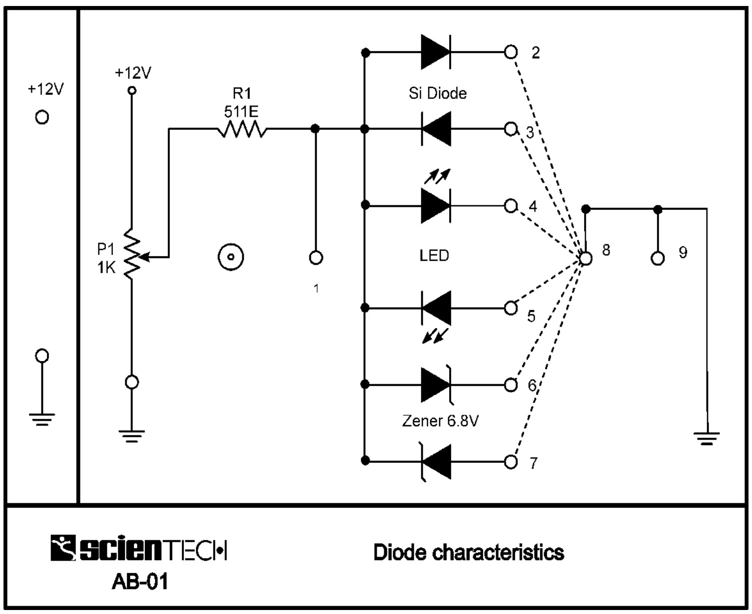


Figure 8

Procedure :

- Connect +12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.
- To plot Forward characteristics proceed as follows:

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).

2. Connect Ammeter between test point 6 and 8 to measure diode current I_z (mA).

3. Connect one voltmeter between test point 1 and 9 to measure voltage V_z diode.

4. Switch 'On' the power supply.

5. Vary the potentiometer P_1 so as to increase the value of Zener voltage V_z from zero to 0.8 in step and measure the corresponding values of diode current I_z in an observation Table 1.

6. Plot a curve between diode voltage V_z and diode current I_z as shown in figure 4 (First quadrant) using suitable scale with the help of observation Table l. This curve is the required forward characteristics of zener diode.

Observation Table 1 :

S. No.	Diode Voltage (V_z)	Diode current I_z (mA)
1.	0.0V	
2.	0.lV	
3.	0.2V	
4.	0.3V	
5.	0.4V	
6.	0.5V	
7.	0.6V	
8.	0.7V	
9.	0.8V	

- To plot Reverse characteristics of a Zener diode proceed as follows

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).
2. Connect Ammeter between test point 7 and 8 to measure diode current I_z (mA).
3. Connect one voltmeter between test point 1 and 9 to measure voltage V_z diode
4. Switch 'On' the power supply.
5. Vary the potentiometer P_1 so as to increase the value of diode voltage V_D from zero to 12V in step and measure the corresponding values of diode current I_z in an observation Table 2.
6. Plot a curve between diode voltage V_z and diode current I_z as shown in figure 4 (third quadrant) using suitable scale with the help of observation Table 2. This curve is the required Reverse characteristics of Zener diode.

Observation Table 2 :

S. No.	Diode Voltage (V_z)	Diode current I_z (mA)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		

Experiment 3

Objective :

Study of characteristics of Light emitting diode (LED) in

1. **Forward bias**
2. **Reverse bias**

Equipments Needed :

1. Analog board of **AB01**
2. DC power supplies +12V from external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).

Circuit diagram :

Circuit used to plot different characteristics of Light Emitting Diode (LED) is shown in figure 9.

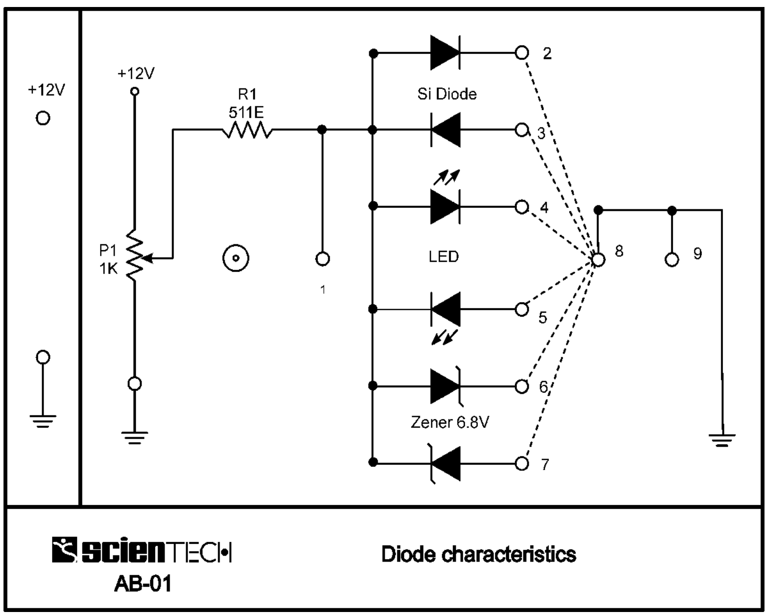


Figure 9

Procedure :

- Connect +12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.
- To plot forward characteristics proceed as follows:

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).
2. Connect Ammeter between test point 4 and 8 to measure diode current I_D (mA).
3. Connect one voltmeter between test point 1 and 9 to measure voltage V_D diode
4. Switch 'On' the power supply.

5. Vary the potentiometer P_1 so as to increase the value of diode voltage V_D from zero t o maximum in steps and measure the corresponding values of diode current I_D in an observation Table 1.

6. Also consider the effect on light intensity with the change in diode voltage and diode current.

7. Plot a curve between diode voltage V_D and diode current I_D as shown in figure 5 using suitable scale with the help of observation Table 1. This curve is the required forward characteristics of Light emitting diode.

Observation Table 1 :

S. No.	Diode Voltage(V_D)	Diode current I_D (mA)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

- To plot Reverse characteristics proceed as follows:

1. Rotate potentiometer P_1 fully in CCW (counter clockwise direction).

2. Connect Ammeter between test point 5 and 8 to measure diode current I_D(μA)

3. Connect one voltmeter between test point 1 and 9 to measure voltage V_D diode.

4. Switch 'On' the power supply.

5. Vary the potentiometer P1 so as to increase the value of diode voltage V_D from zero to maximum in steps and measure the corresponding values of diode current 1_D in an observation Table 2.

6. Plot a curve between diode voltage V_D and diode current 1_D as shown in figure 5 (Third quadrant) using suitable scale with the help of observation Table 2. This curve is the required forward characteristics of Light emitting diode.

Observation Table 2 :

S. No.	Diode Voltage(V_D)	Diode current I_D (mA)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		

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

Updated 08-01-2009