AB33
Transistor Shunt
Voltage Regulator

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

Innovative Technology Ecosystem

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Transistor Shunt Voltage Regulator
AB33

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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

AB33 is a compact, ready to use **Transistor Shunt Voltage Regulator** experiment board. This is useful for students to study the operation of Transistor as a voltage regulator when it is connected in shunt or parallel with load. 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
AB32	Transistor Series 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.

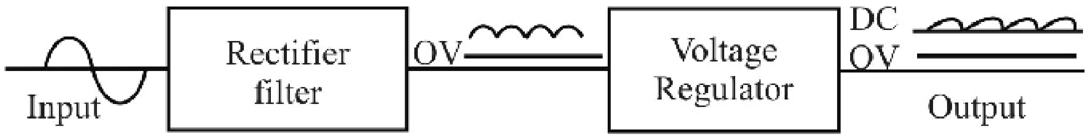


Figure 1

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.

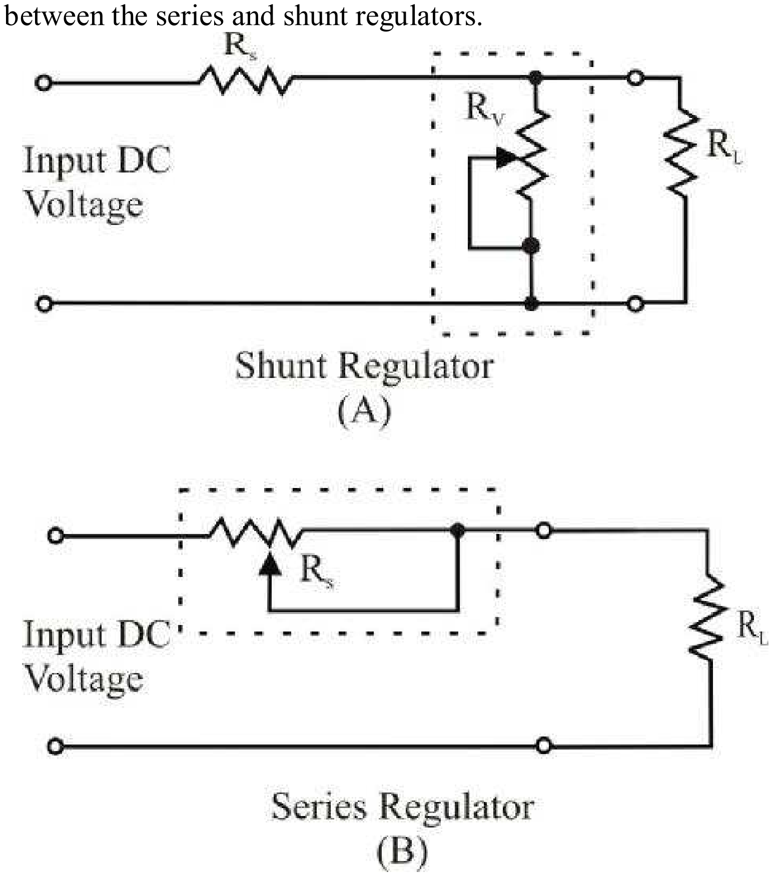


Figure 2

The schematic drawing in view A is that of a shunt regulator. It is called shunt regulator because the regulating device is connected in shunt or in parallel with the load resistance. Figure 2 illustrates the principle of shunt voltage regulation. From the Figure it is clear that the regulator is in shunt with the load resistance (R_L). In a shunt voltage regulator, as shown in Figure 2, Output voltage regulation is determined by parallel resistance of the regulating device, the Load resistance (R_L), and the series resistor Rs. If the load resistance R_L increases/decreases, the regulating device decreases/increases its resistance to compensate for the change.

The schematic for a typical series voltage regulator is shown in Figure 3. It employs the NPN transistor in shunt configuration in place of the variable resistor found in Figure 2.

Since AB is in parallel across V_L, we have

$$V_L - V_Z - V_{BE} = 0 \text{ or } V_{BE} = V_L - V_Z \quad \text{(kirchoff's Voltage Law)}$$

Also $V_L = V_Z + V_{BE}$

i.e. The output voltage is close to the sum of the voltage across Zener and the voltage at the base-emitter junction of transistor.

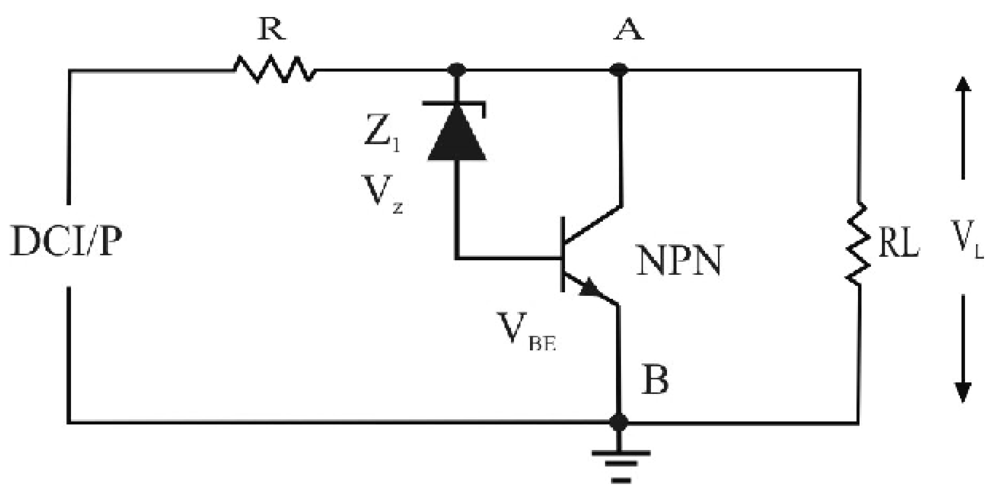


Figure 3

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

Circuit Operation :

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

Since V_Z is fixed, any decrease or increase in V_L will have a corresponding effect on V_{BE}. Suppose, V_L decreases, then as seen from the above relation V_{BE} also decreases. As a result, I_B decreases, hence I_C (= βI_B) decreases, thereby decreasing I and hence V_R (=IR). Consequently, V_L increases because at all times

$$V_{in} = V_R + V_L \text{ or } V_L = V_{in} - V_R$$

From the above description it is concluded that when by any reason V_L decreases V_R also decreases thereby keeping V_L constant.

Similarly, when by any reason V_L increases V_R also increases thereby keeping V_L constant.

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

When the input voltage increases, output voltage across R_L also increases momentarily. This momentarily deviation or variation, from the required regulated output voltage of 6.3 volts is a result of a rise in the input voltage. This increases forward bias of transistor. Recall that the voltage drop across Zener remains constant at 5.6V. Since the output voltage is composed of the Zener voltage and the base-emitter voltage, the output voltage momentarily increases. At this time, the increase in the forward bias of transistor lowers the resistance of the transistor allowing more current to flow through it. Since this current must also pass through R, there is also an increase in the voltage drop across this resistor. Due to increase in this voltage drop across R, voltage across V_L remains close to the required regulated value of output voltage.

Similarly, when input voltage decreases, forward bias of transistor also decreases. This decrease in bias voltage increases the resistance of transistor allowing less current to flow through it. Since this current must pass through resistor R, there is also an decrease in the voltage drop across this resistor. This drop in voltage across R maintains output voltage close to the required regulated value.

Experiment 1

Objective :

Study of Transistor shunt voltage regulator, when input voltage V_{in} is fixed while Load resistance R_L is variable.

Equipments Needed :

1. Analog board of **AB33.**
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 Transistor shunt voltage regulator is shown in figure 4.

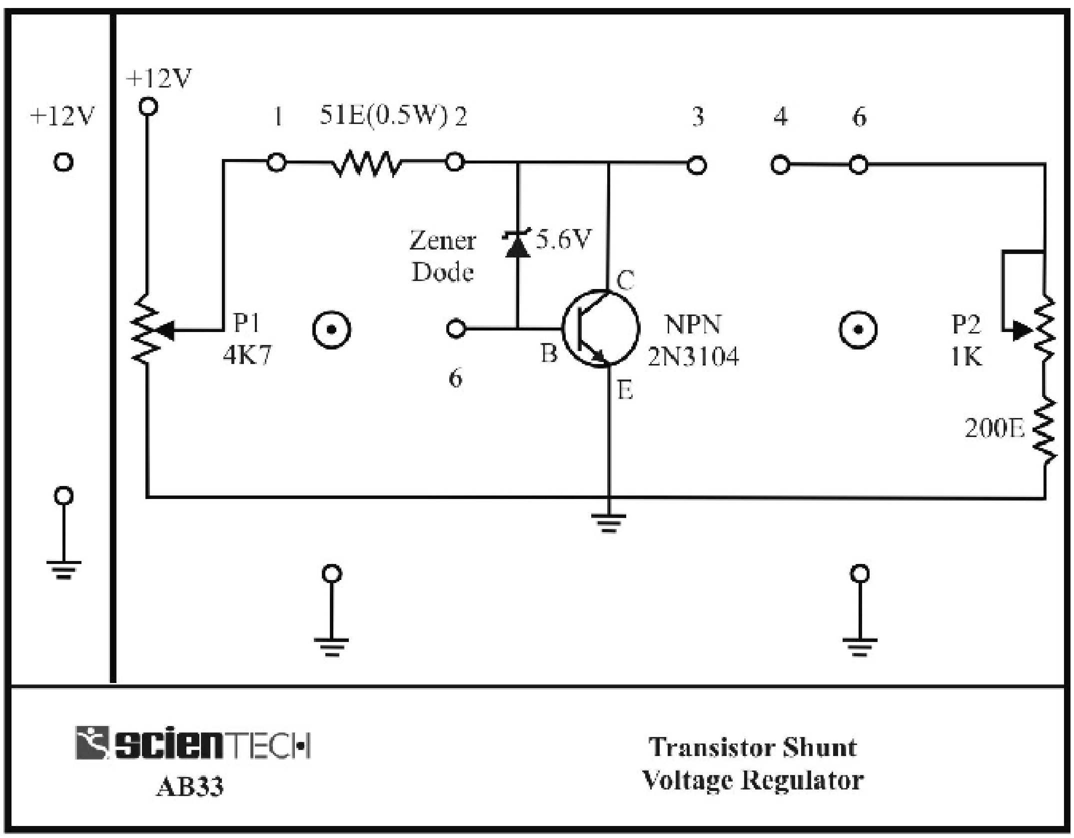


Figure 4

Procedure :

- Connect + 12V DC power supply at its 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 5 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 3 and 4.

4. Connect voltmeter between test point 5 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 5 and ground.

   b. Zener voltage V_Z between test points 2 and 6.

   c. Forward bias voltage V_{BE} of transistor between test point 6 and ground.

7. Disconnect the 2mm patch cord between test point 3 and 4.

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.	1KΩ			
3.	800Ω			
4.	600Ω			
5.	400Ω			
6.	200Ω			
7.	No Load			

Note : To measure Voltage at No Load disconnect 2mm patch cord between test point 3 and 4, measure voltage between test point 3 and ground.

Calculations :

Percentage regulation is given by formula

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

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 3 with a fixed input voltage V_{in} the output voltage will remain close to 6.3 V for a range of load resistance that extends from ______ to _______ .

2. Percentage regulation = _______%.

Experiment 2

Objective :

Study of Transistor shunt voltage regulator, when input voltage V_{in} is variable while Load resistance R_L is fixed.

Equipments Needed :

1. Analog board of **AB33.**
2. DC power suppy +12V external source or **ST2612 Analog Lab**.
3. Digital Multimeter (2 numbers).
4. 2mm patch cords.

Circuit diagram :

Circuit used to study Transistor shunt voltage regulator is shown in figure 5.

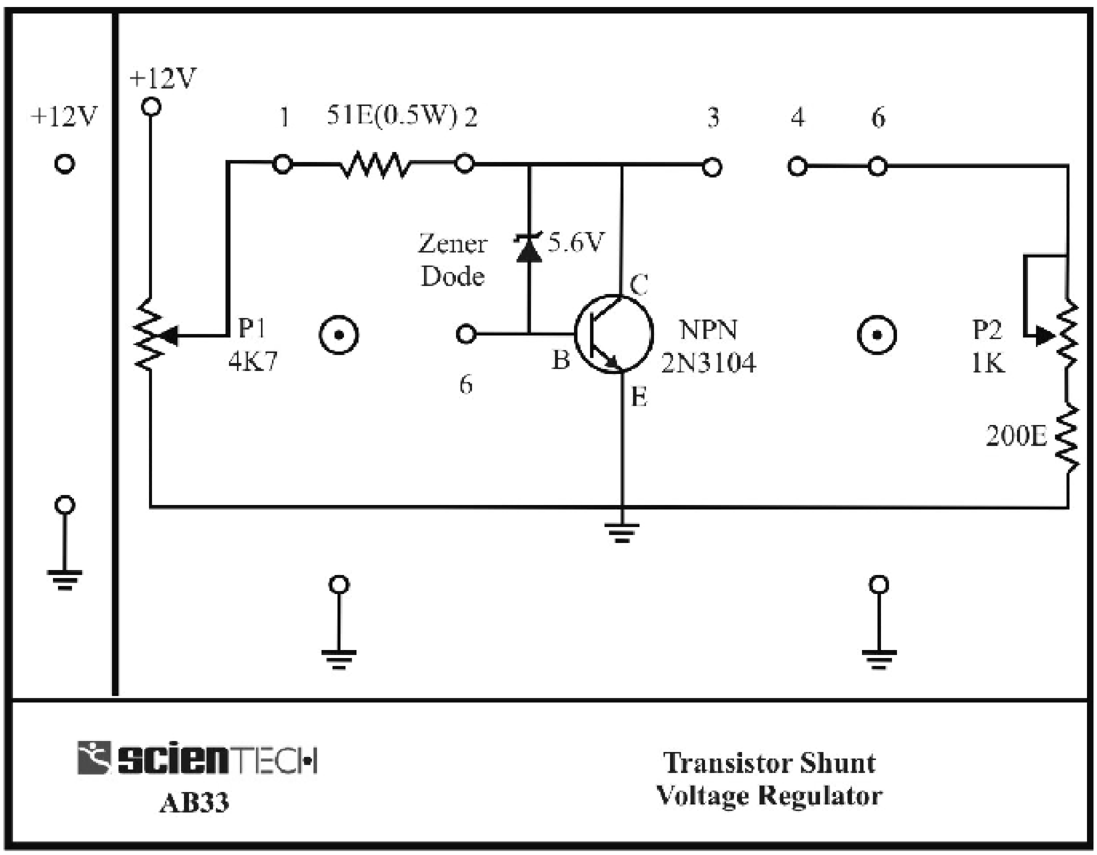


Figure 5

Procedure :

- Connect +12V DC power supplies 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 5 and ground and set the value of load resistance R_L at maximum value.

3. Connect a 2mm patch cord between test point 3 and 4.

4. Connect voltmeter between test point 5 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 5 and ground.

   b. Zener voltage V_Z between test points 2 and 6.

   c. Forward bias voltage V_{BE} of transistor between test point 6 and ground.

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 :

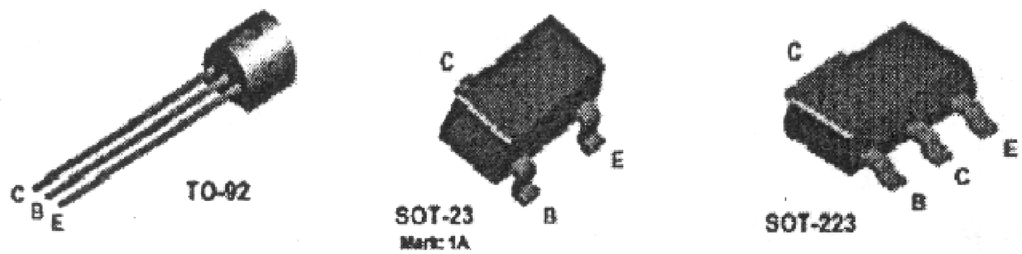
Sr. No.	Input Voltage V_{in}	Voltage Across Zener V_Z	Forward bias voltage V_{BE}	Output voltage V_{out} at fixed load resistance R_L = Max
1.	7 V			
2.	8 V			
3.	9 V			
4.	10 V			
5.	11 V			

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 6.3V for a range of input voltage V_{in} that extends from _____ to_____ .

Data Sheet

2N3904 MMBT3904 PZT3904



NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

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	60	V
V_{EBO}	Emitter-Base Voltage	6.0	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.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		2N3904	*MMBT3904	**PZT3904	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

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

Updated 26-06-2009