

# TESTIT FD20

## User's manual



WESTKONE OY/AB

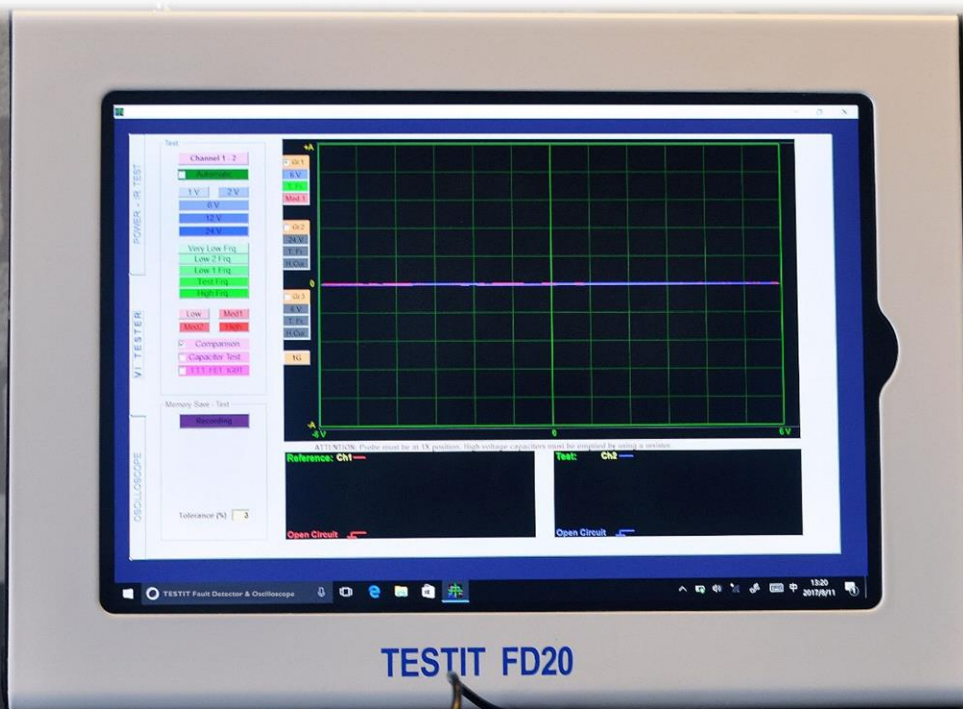


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## PRODUCT DESCRIPTION

### TESTIT FD20 FAULT DETECTOR & OSCILLOSCOPE

The **TESTIT FD20 Fault Detector & Oscilloscope** from **WESTKONE OY/AB FINLAND** is designed to diagnose the failures in all types of electronic circuit boards. The TESTIT FD20 is a pc based VI Test Voltage-Current Analysis device.

**Signature Analysis** is a power-off test method that is used to troubleshoot circuit boards.

TESTIT FD20 works by applying a current-limited sine wave through a serial resistor point touched on circuit and Voltage. Current (Signature) graph is displayed on the computer screen. In addition to these features, the computer software analyzes the Voltage/Current graph and displays the equivalent circuit diagram along with the values of the electronic components at the point of contact. This assists the user to easily diagnose failure points.

Using the **Dual Channel VI Test** feature, the intact and defective (or suspect) electronic circuit boards can be compared by probing the same points respectively. Any failures beyond tolerances are diagnosed easily. All the VI graphs are compared by the software with an accuracy of 2.5 mV and by analyzing 720 points. For this reason the TESTIT FD20 is very accurate.

**The Memory Recording** feature writes the characteristics of the intact electronic circuit board to the computer's hard disk. This includes the VI graph, equivalent circuit diagram and electronic components values. Using these points as a reference you can accurately compare them with the assumed to be defective electronic circuit boards easily and rapidly. The data can also be simultaneously written onto an image of the board. This allows the recorded points to easily be seen on the image as comparisons are made from the recorded memory.

The software **produces different sounds** while comparing matching and non-matching points during the test. Comparisons can be made rapidly by listening to the sounds without the need to look at the display. The user can compare the electronic circuit boards from three different settings simultaneously by Selecting distinct Current, Voltage, and Frequency steps)

In addition to the above features, the VI TESTIT FD20 Test Device can be used as a **Dual Channel Oscilloscope, Square Wave Generator** and **Analog Voltage Output**. When the Square Wave Signal Output is used, a signal is applied to the electronic circuit board and the channels display the output signals on the oscilloscope screen.

**Two more unique features** have also been added to the TESTIT FD20 in addition to the model TESTIT10. The first one of these features is the "**Programmable DC Power Supply**"; by using the adjustable power output of 0 to 16V and 20 to 1500mA, the DC Voltage/Current graph of the



circuit can be obtained. The second unique feature is the **"IR Remote Temperature Measurement Probe"**, which is used for identifying overheating components drawing excessive current. With the combination of these two features, failures can be diagnosed up to 5 to 10 times faster.

Technicians, engineers and hobbyist consider the VI graphs as an effective and efficient method for diagnosing failures in printed circuit boards. Comparing the VI signature provides the user a quick and clear method of identifying the defective area and components. After gaining some experience with the VI graphs, you will find the TESTIT FD20 to be an indispensable troubleshooting tool for diagnosing electronic circuit boards. It is simple to use; failures can be identified by looking at the graphs without the need to make other comparisons.

When you test electronic cards with the TESTIT FD20, do not energize the board. Also make sure to discharge high voltage capacitors on the board in advance. The TESTIT FD20 device does not cause damage to electronic circuit boards.

### Usage Areas

ECU Automotive electronic circuit boards, servo-step motor drivers, circuit boards of medical devices, military electronic circuit boards, computer and monitor circuit boards, television-audio radio circuit boards, circuit boards of textile machines, mobile phone electronic circuit boards etc. (all types of electronic circuit boards.)

**Electronic Component Test:** Can be used to test all electronic components. Resistors, Capacitors, Inductors, Diodes (general purpose Diodes, Zener and High Voltage Diodes etc.), Transistors (NPN, PNP, JFET, MOSFET vs.), SCR, Triac, Optocouplers, Integrated Circuits (Digital, Analog vs.).

### Unique Features

You can generate a **DC Voltage-Current Graph** of the electronic circuit board's power supply. The Programmable DC Power Supply, **IR (infrared) Sensor (Temperature Test)**, **Equivalent Circuit Diagram** and **Measuring Values** of all components features are **unique** and cannot be found in any other similar products.

The "Programmable DC Power Supply" allows output adjustments of between 0 to 16V and 20 to 1500mA. It provides energy to the circuit board, creating the Power DC Voltage-Current Graph. The "IR Remote Temperature Measurement Probe" sensor is used to identify overheating components as a result of drawing too much current.

The Equivalent Circuit Diagram and Measuring Values of all components feature creates and displays a circuit diagram of measured circuits. For example, if a resistor is connected parallel to a capacitor, it will show both a circuit diagram and the value of the components.

## SECURITY AND SAFETY

TESTIT FD20 is produced by using lead-free solder and designed in accordance **CE** and **CCC** regulations; users must use the following usage rules:

- 1-** Chassis must be isolated and grounded. The chassis ground connection point of the probe is the same as your computer. Be careful to avoid any potential difference.
- 2-** Features of oscilloscope: if probe key is set to 1X, it measures  $\pm 5$  Volts. If probe key is set to 10X, it measures  $\pm 50$  Volts. Do not use above these voltage limits.
- 3-** Electronic circuit boards are tested without applying energy. Before testing the electronic circuit board high-voltage capacitors must be discharged.
- 4-** The users of this equipment must have knowledge and experience of electronic circuit board repair.

While using the TESTIT FD20:

- DO NOT** connect chassis to high-voltage or non-isolated ground
- DO NOT** test high-voltage capacitor without discharging first.

Unless you have adequate knowledge and experience in this area, keep away from high voltages. Mains voltage can for example result in damage to the device and harm to the user.

- 5-** Applying high-voltages to the probes can cause the series resistors contained in the device to be damaged and making the circuit an open circuit. In this case, the computer port which is connected device via the USB port is damaged but other parts of the computer is not damaged.

## TESTIT FD20 PERFORMANCE AND MEASUREMENT TOLERANCE

- 1-** TESTIT FD20 is designed as a multi-function Voltage- Current (VI) Signature Analysis Tester and Oscilloscope. The primary feature of the device is the VI Tester. The computer software is also capable of analyzing the voltage-current graph in order to display an equivalent circuit diagram with values of the electronic components along with specific tolerances. The equivalent circuit diagram and values are for informational purposes only. Computer software creates the "Power Voltage-Current Graph" and measures components within specific tolerances.

**2-** The Equivalent circuit diagram is drawn by software using mathematical functions and formulas. With mistakes only possible in rare circumstances. This possibility is increased in the presence of external electromagnetic fields. EMC Testing: 3V/M and the range of 80MHz-1GHz is approximately capacitor %1, resistor %3, diodes %1. Some fast diodes oscillate in some frequencies, which might be perceived as an 'active point' by the device. VI Graph the rate of change: <1%.

**3- Component Value Measurement Tolerance:**

- Resistor: 2 %
- Capacitor: 3 %
- Diode Transmission Voltage: 0,1V
- If Resistor and Capacitor are connected in Parallel: Resistor:4 %, Capacitor: 5 %
- If Resistor and Diodes are connected in Series: 4 %
- If Diode and Resistor are connected in Parallel: 3 %
- If two Diodes and a Resistor are connected in Parallel: 10 %

**Note 1:** These tolerances are valid if the resistor curve creates an angle between 10 and 80 degrees to the horizontal axis. If resistor curve is near the horizontal line, select "Low Current Stage." If resistor curve is close to the vertical line, select "Middle or High Current Stage" to reduce error rate.

**Note 2:** These tolerances are valid if the capacitor ellipse width/length ratio is greater than 1/4. If this ratio is less than 1/4 the ellipse's width (i.e. length is thin and long), change the current step and/or the frequency step in order to select the step appropriate to the component.

Oscilloscope voltage measurement tolerance: 0,5 %.

## **Product and Package Contents**

- TESTIT FD20 Tester 1 unit
- IR Temperature Probe 1 pc
- Oscilloscope Probes 1 par
- Clip Leads 1 par
- Wireless Mouse 1 pc
- Tool Kit 1 set
- Power Adapter 1 pc
- Touch Pen 1 pc (optional)
- TESTIT FD20 Hard Carrying Case 1 pc
- User Manual in Flash Drive 1pc
- Copy of Testing Software in Flash Drive 1 pc
- Windows10 Pro OS in Flash Drive 1pc



Figure 1: TESTIT FD20 Unit Set



Figure 2 : TESTIT FD20 Front View

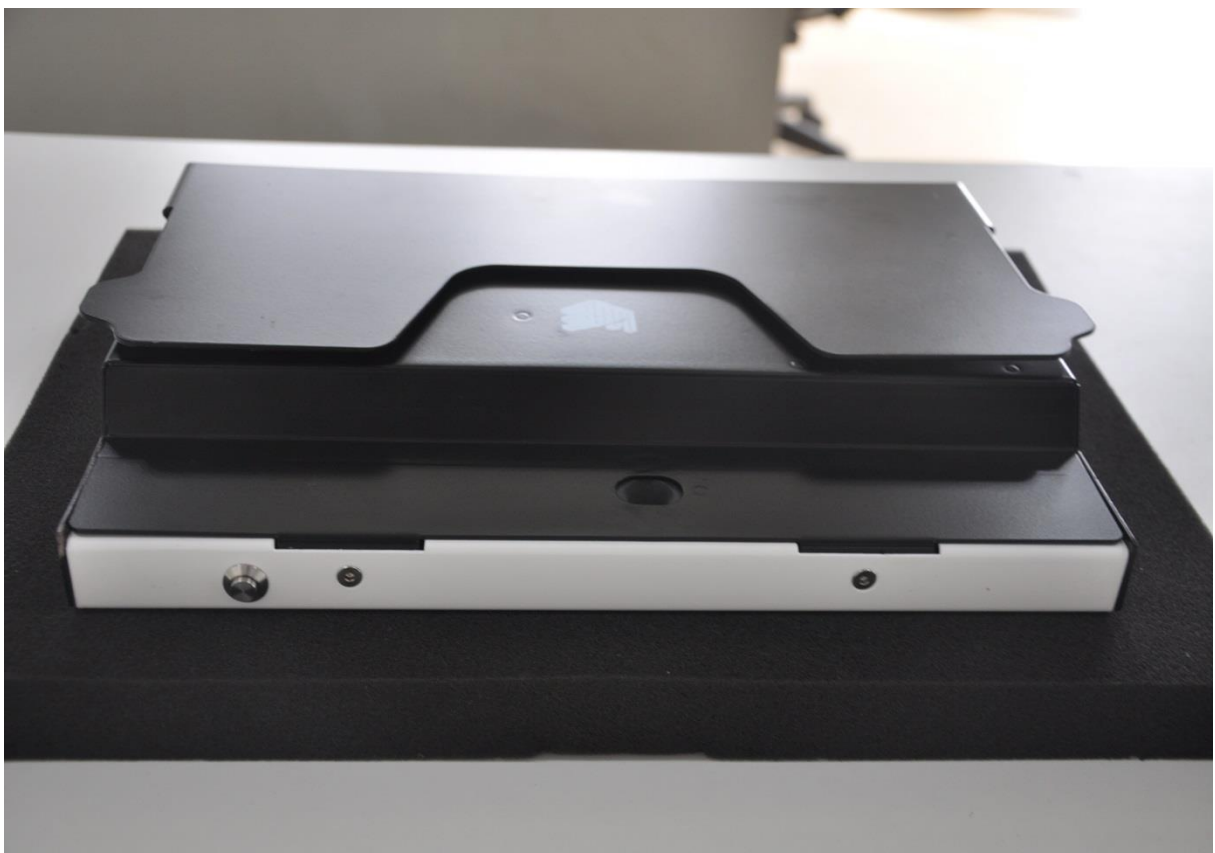


Figure 3 : TESTIT FD20 Back Side With Kickstand Closed



Figure 4 : TESTIT FD20 Back Side With Kickstand Open



Figure 5 : TESTIT FD20 Left Side View



Figure 6 : TESTIT FD20 Right Side View





Figure 7 : TESTIT FD20 Bottom View



Figure 8 : TESTIT FD20 Hard Carrying Case



## TESTIT FD20 TECHNICAL SPECIFICATIONS

### A- FAULT DETECTION SPECIFICATIONS:

<b>Test Voltage</b>	: $\pm 1V$ , $\pm 2V$ , $\pm 6V$ , $\pm 12V$ , $\pm 24V$		
<b>Test Resistance</b>	: Low $47K\Omega$ , Medium1 $3,5K\Omega$ , Medium2 $700\Omega$ , High $250\Omega$		
<b>Test Frequency</b>	Very Low Frequency	: 2	Hz
	Low2 Frequency	: 4	Hz
	Low1 Frequency	: 12	Hz
	Test Frequency	: 32.5	Hz
	High Frequency	: 355.4	Hz
<b>Number of Channels</b>	: 2 (Channel1 and Channel2)		
<b>Scan Mode</b>	: Manual and Automatic. Automatic selection steps Voltage, Current and Frequency.		
<b>Other characteristics</b>	: <b>1:</b> Equivalent circuit diagram.		
	: <b>2:</b> Resistor, capacitor, diode measurement.		
	: <b>3:</b> Data recording and comparison from memory.		
	: <b>4:</b> Display of graphs in different settings simultaneously.		

### B- POWER – IR TEMPERATURE FEATURES:

<b>DC Power Supply</b>	: Power output adjustable between 0-16V and 20-1500mA.
<b>IR (Infrared) Sensor</b>	: Measures 0 to 120 degrees according to the room temperature.

### C- PC OSCILLOSCOPE FEATURES:

<b>Sampling Rate</b>	: 400 K/S
<b>Input Voltage</b>	: Probe 1X: $\pm 5 V$ Probe 10X: $\pm 50 V$
<b>Channel/ADC</b>	: 2 Channel / 12 Bit
<b>Accuracy</b>	: 2,5 mV
<b>Display Speed</b>	: 0.02 mS/div...100 mS/div
<b>Momentary Memory</b>	: 64 Kbyte

### D- DIGITAL AND ANALOG OUTPUT:

<b>Output</b>	: Channel2
<b>Output Voltage</b>	: -12V...+12V (adjustable)
<b>Frequency (Digital)</b>	: From 0.2KHz to 25KHz
<b>Connections</b>	: The probes may be connected to all the connectors. The probe with the yellow band is always Channel 1 and the probe with the blue band is always Channel 2. The crocodile probe is always Com.
<b>Dimensions</b>	: 122mm L x 113mm W x 29mm H
<b>Weight</b>	: 1100 gram including all accessories.

Table 1: TESTIT FD20 Technical Features

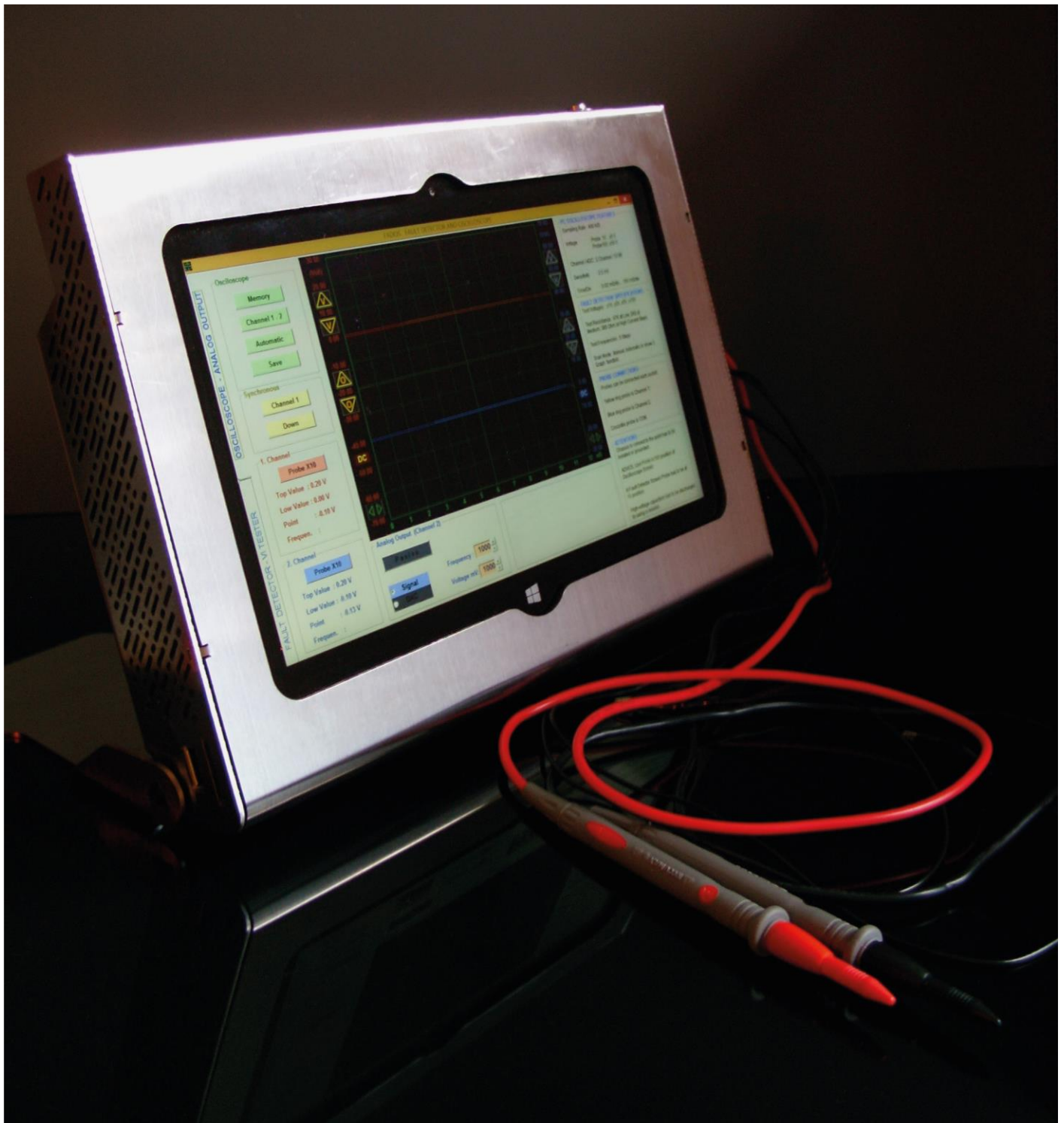


Figure 9 : TESTIT FD20

**TESTIT FD20** includes 9 important functions:

**1. Double Channel Fault Detection (Analog Signature Analysis - VI Graph)**

Compares good and faulty or suspect circuit boards without powering boards.

**2. Programmable Integrated DC Power Supply**

Provides energy to circuit boards and creates the DC Power Voltage-Current Graph.

**3. IR Temperature Sensor**

For detecting heated components and drawing a heat map of circuit board.

#### 4. Equivalent Circuit Diagram

Display of Resistor, Capacitor, or Diode Circuit Diagram according to the point touched.

#### 5. Measurement of Values of Resistors, Capacitors, and Diodes

– the value of touched points can be quickly measured.

#### 6. Fault Detection Comparison from Memory

By recording data of good circuit boards to memory, it is possible to compare faulty or suspects boards from memory.

#### 7. Double Channel Digital Oscilloscope

Device can be used as an oscilloscope when needed.

#### 8. Square Wave Signal Output

Ch.1 is used as oscilloscope and Ch.2 is used as signal generator.

#### 9. Analogue Voltage Output

Ch.1 is used as oscilloscope and Ch.2 provides analog voltage output.

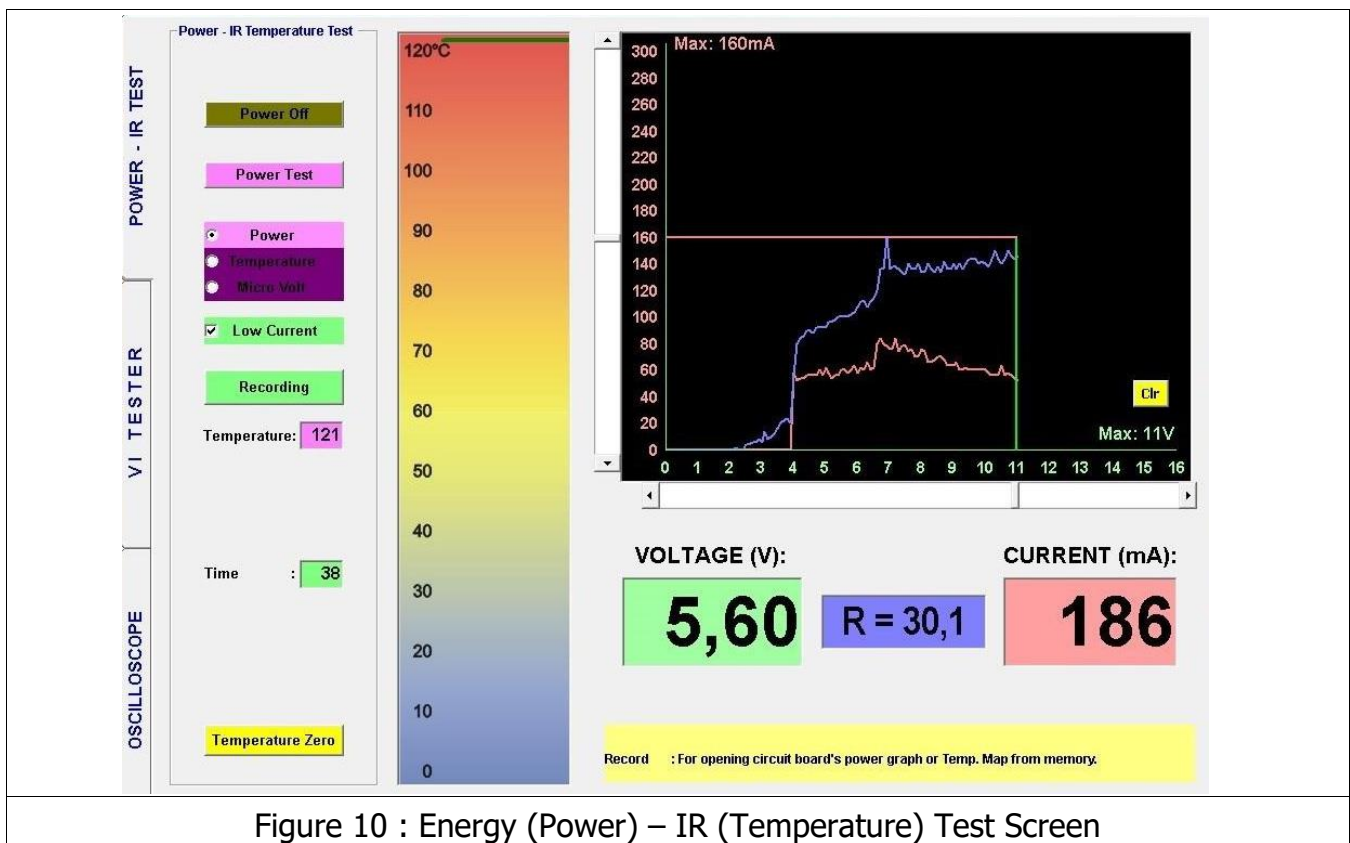


Figure 10 : Energy (Power) – IR (Temperature) Test Screen

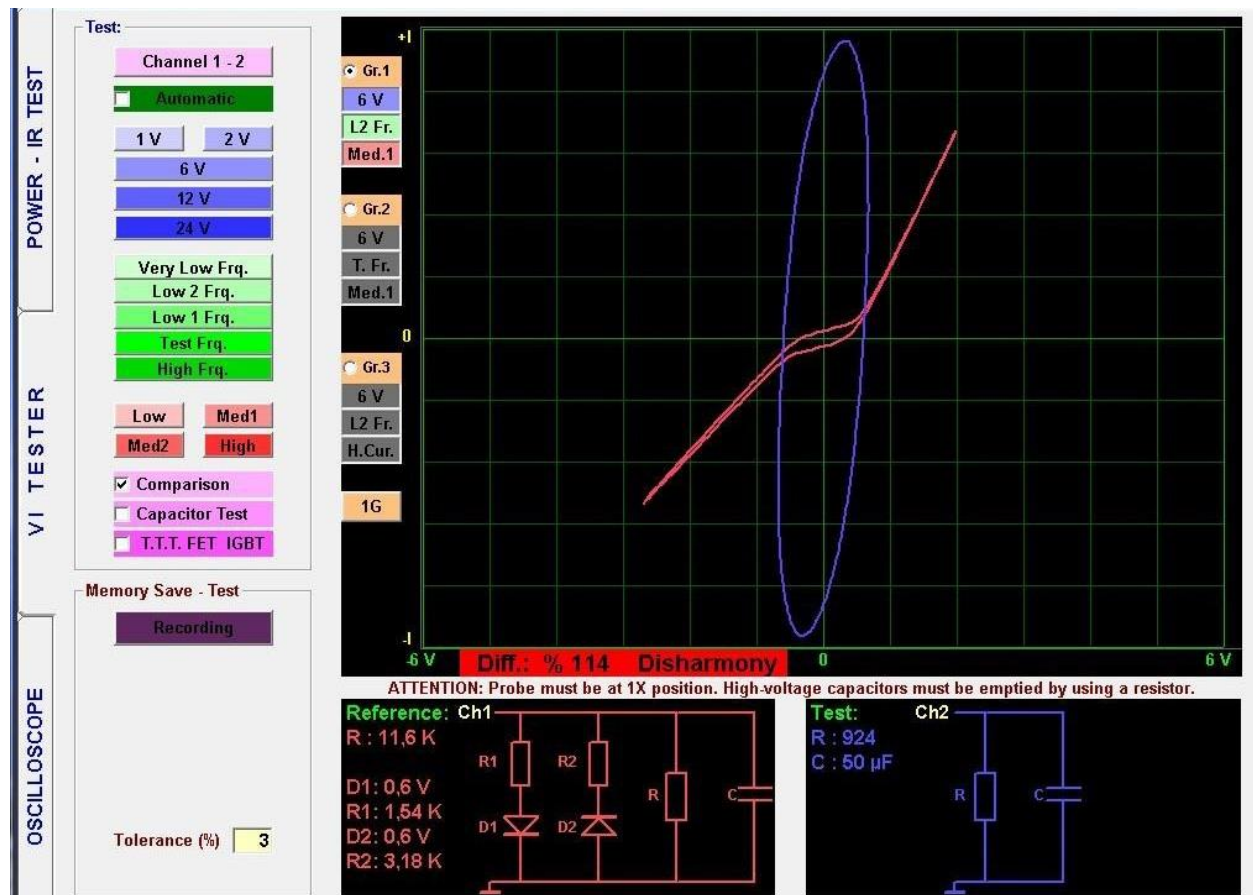


Figure 11: Fault Detector – VI Tester Screen

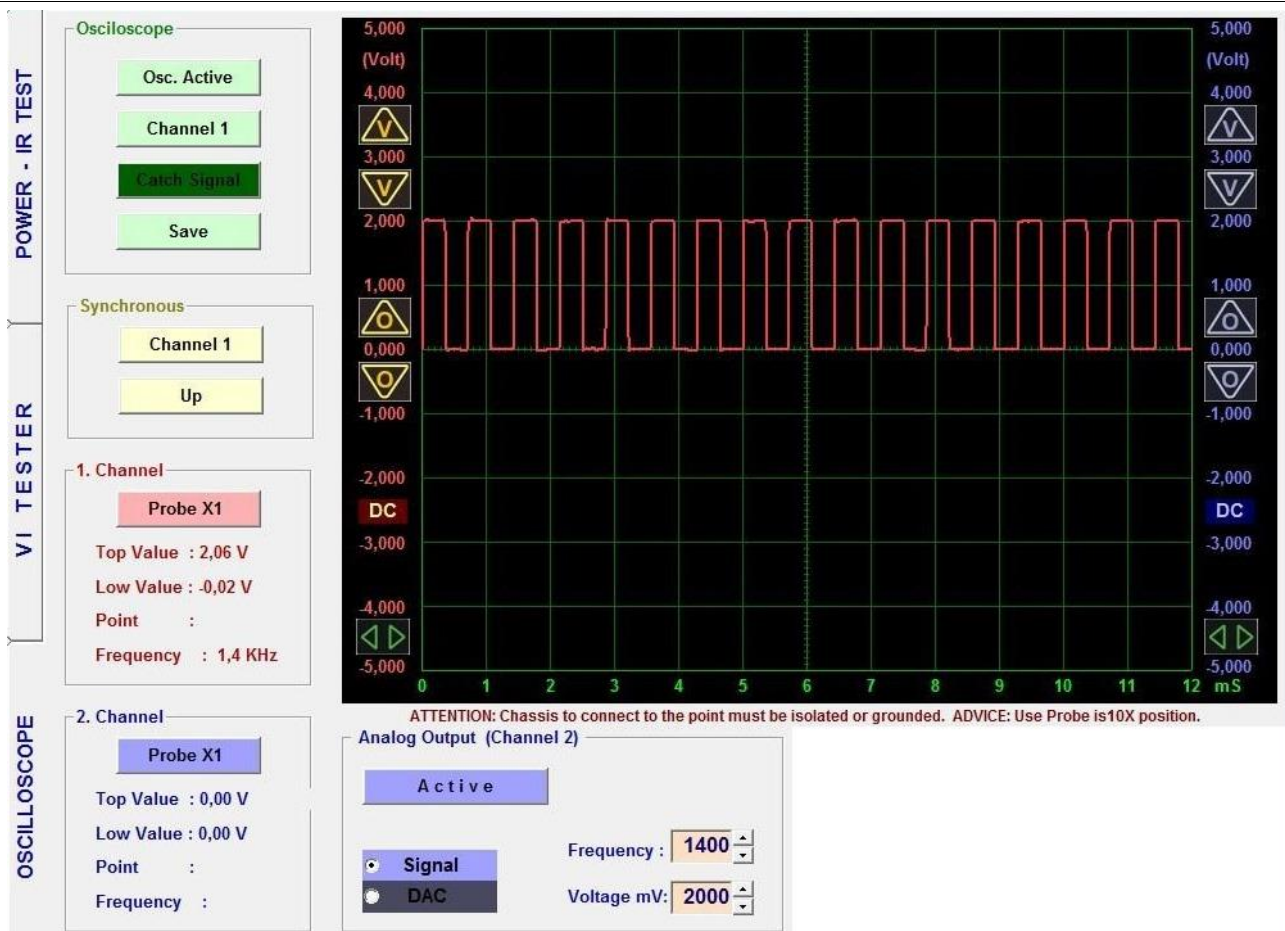


Figure 12: Oscilloscope – Analog Output Screen



## CONNECTING THE TEST PROBES

Connect the DC Power Cable (Red-Black Cable) to the Power Connector. IR Sensor Probe is connected to the IR TEMP. Connector. The Oscilloscope Probes and Com Probe (Crocodile) can be attached to all the connectors labeled VI TESTER. The probe with the Red Band is always Channel 1, and the probe with the Blue Band is always Channel 2. The Crocodile Probe is always "COM". The Power Adaptor is connected to mains plug (18 – 20 VDC).



Figure 13: TESTIT FD20 Accessory

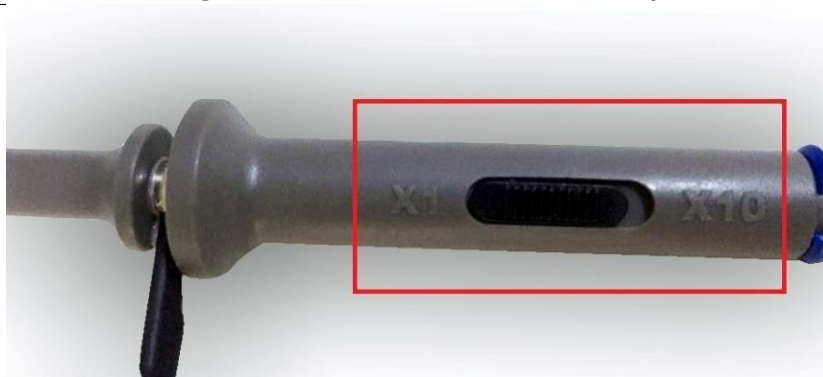


Figure 14: Probe in X1 Position

## GENERAL USAGE INFORMATION

1. When running the software, The Power/IR Temperature Test Screen opens and an input is displayed of the VI Tester Screen or Oscilloscope Analog Output Screen.

While testing the electronic circuit boards, we recommend that the user use the Power/IR Temperature Test feature.

- First, create the good circuit board's "Power Voltage/Current Graph". Then save this graph to memory.
  - The faulty or suspect electronic circuit board's "Power Voltage/Current Graph" is compared with the good electronic circuit board's graph.
  - If the faulty or suspect board draws too much current, it means that one or more components on the board will heat up. Use the IR sensor for troubleshooting the hot components.
  - If defective board draws less current than the intact board it means there is likely an open circuit on the board. In that case, open the "Oscilloscope Screen" to diagnose the broken circuit.
  - If the graph of the faulty (defective) board is the same as the good board, the faulty component can be diagnosed by opening the "VI Tester Screen".
2. Open the circuit's graph is in the middle and horizontal position at the Test-Fault Detect screen. Current/Voltage Graph (VI) displays an angle according to the value of the resistance. A capacitor displays a circle or ellipse. A short circuit is displayed as a vertical line.
  3. In the Medium current mode, when using high resistor values, the VI graph is closer to the horizontal axis. You can see the resistors with high values more clearly by switching to low current. If the VI graph is too close to the vertical axis, this means that the resistor value is low and you can read the values more clearly by switching to the high current mode.
  4. Generally you will test capacitors in the test frequency mode. Use low current when the capacitor value is low and high current if the value is large. If the capacitor value resembles a thin line in high current at the vertical axis, you can see the value more clearly by reducing the frequency from the frequency mode.
  5. The pins of a good integrated circuit are generally in the form of a dual reverse diode (other than the supply and ground). Although the attached resistors and/or capacitors might affect the graph, two reverse diodes should be observed. In the output of some integrated circuit only one diode may also be seen. An image in form of a resistor would most probably mean a defective integrated chip.
  6. The capacity test shows the quality of the electrolytic capacitor. The more horizontal this curve is, the higher the quality of the capacitor is. The angle of the deteriorating capacitor makes an

angle with the horizontal axis. If the angle is large, it means a defective capacitor. Because the circuit draws a current while testing the board this test can be deceptive. In case of doubt, remove the capacitor from the circuit and then measure; in this measurement, the test devices may show the circuit intact. The best capacitor quality measurements can be done by looking at the "Capacity-Resistor Curve". While making this measurement, adjust the frequency and current to become longer along the vertical axis of the graph. Avoid forming multiple and thin graphs.

7. In case of a misshapen capacitor graph due to the effects of diodes in the circuit, the value of the capacitor can be measured after eliminating the effects of the diodes.
8. The key in troubleshooting is to understand the shape of the graphs and their interpretations. Try to find the defects by comparison. You should be able to distinguish the graphs of the good and defective materials in a short time. The Equivalent circuit diagram and values will aid you in the process. If you concentrate on only the values in the equivalent circuit, diagnoses may take longer. Use the values of the components as necessary, but do not rely on the values alone. The evaluation logic of this product is based on the interpretation of the graphs, i.e. interpreting the graphs produced by the computer and generating the equivalent circuit diagram and showing the associated values.

## **POWER (SUPPLY) - IR TEMPERATURE TEST**

When you run the Program, the Power (Energy) - IR Temperature Test Screen is opened. Energize the electronic circuit board in the Power (Energy) - IR Temperature Test section to generate a DC VI Graph. The amount of current drawn by the board can be seen. The temperature of the electronic components may also be measured using the IR (Infrared) Sensor. All the control keys to be used for the Power (Supply) IR Test are located on the left hand side of the panel.



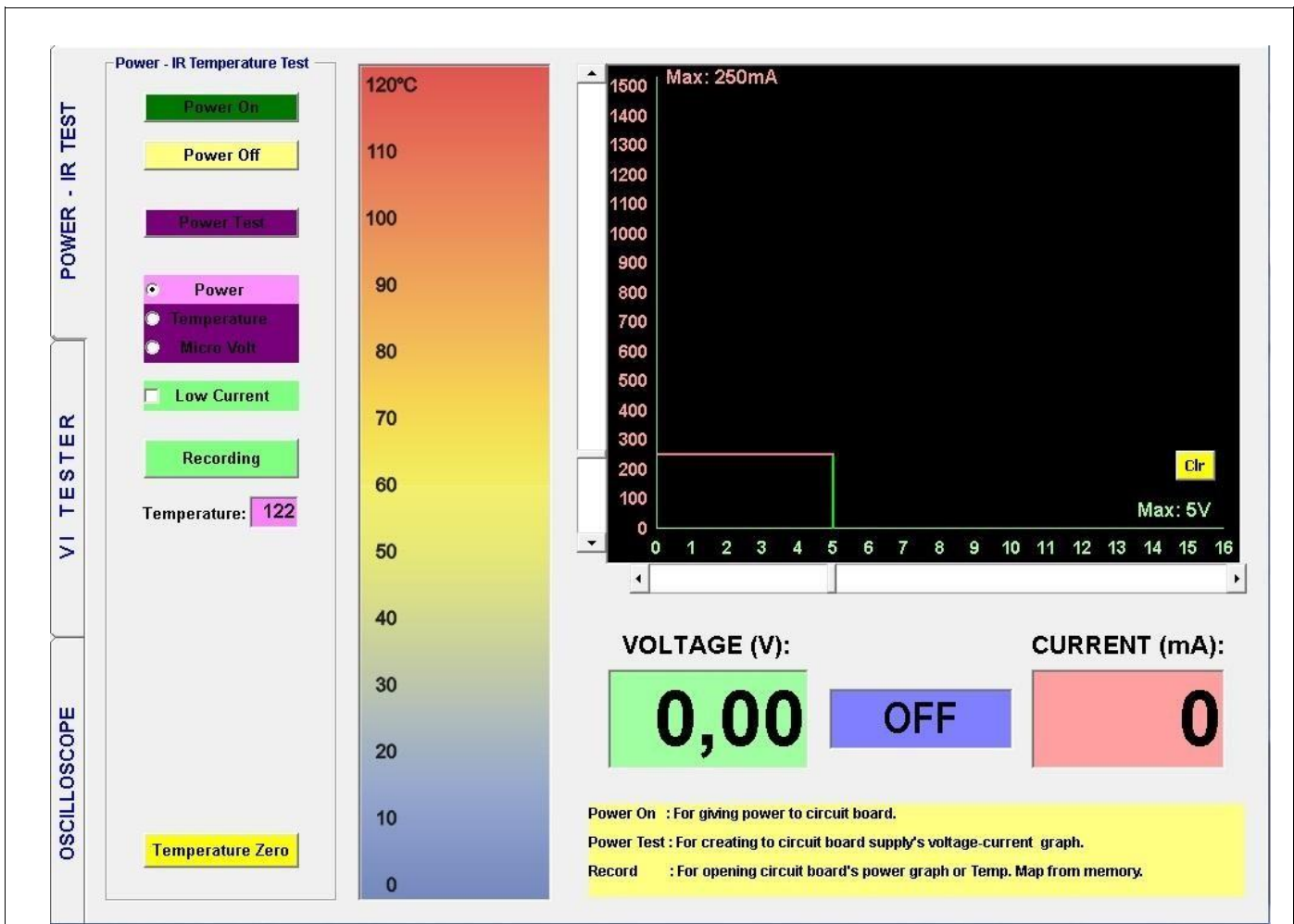
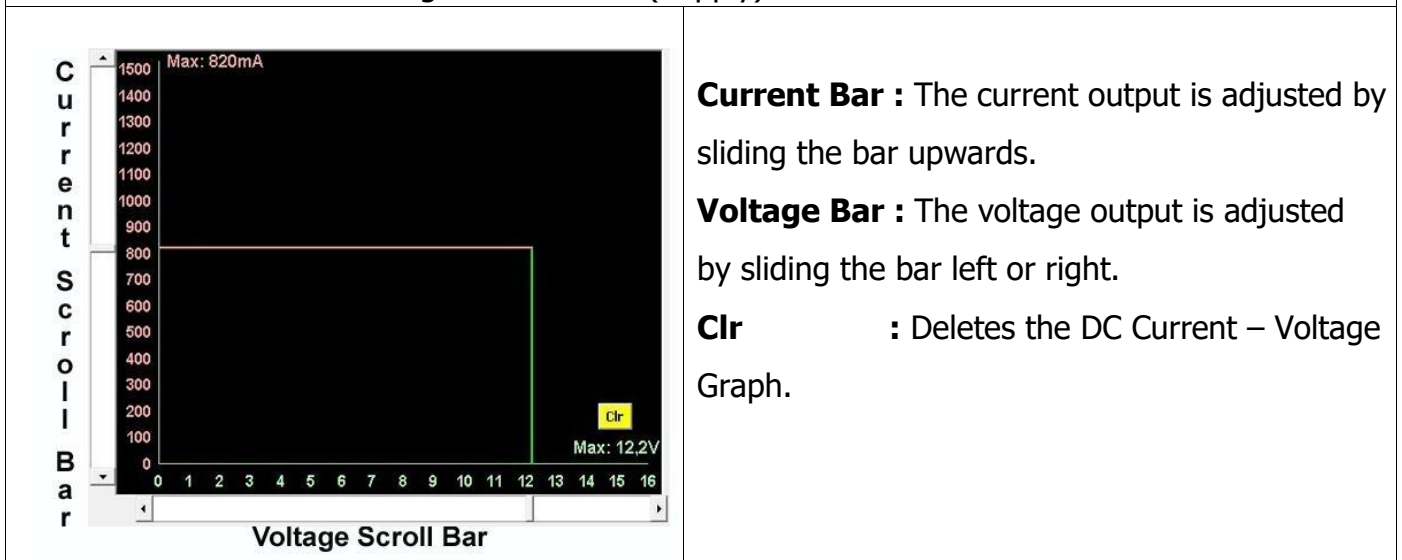


Figure 15: Power (Supply) - IR Test Screen



Power On

Power Off

Power Test

☒ Power

☐ Temperature

☐ Micro Volt

☐ Low Current

Recording

Temperature: 0

Recorded Temperature: 0

Temp. Tol.  $\pm$  : 2

Test Point : 0

Time : 0

☐ Auto. Test

Next Point

Temperature Zero

**Power On** : The TESTIT FD20 gives an "Output" through the DC Power cables. If the electronic circuit board draws more than the current adjusted, the program limits the current to prevent the board from drawing excessive current.

**Power Off** : Cuts off the Voltage.

**Power Test** : Used for generating the "Current/Voltage Graph" of the electronic circuit board's power supply.

**Power** : Selected for the DC Power Test and measurement.

**Temperature** : Selected for the IR – Temperature Test and measurements.

**Micro Volt** : Selected for the Microvolt measurements.

**Low Current** : Selected for accurate measurements between 0-300 milli amperes.

**Recording** : Opens the Records Window.

**Temperature** : Shows the temperature values of the electronic components tested with the IR sensor.

**Recorded Temperature** : Shows the temperature values of the electronic components stored in the memory.

**Temp. Tol.  $\pm$**  : Shows the  $\pm$  Temperature Tolerance value. The user can change the tolerance.

**Test Point** : Shows the serial number of the electronic component stored in the memory.

**Time** : Counts down from 90 seconds.

**Auto Test** : If the electronic component is within the tolerance value of the data stored, the next data are opened automatically.

**Next Point** : Opens the next data stored.

**Temperature Zero** : Used for compensating the IR sensor for the room temperature.

VOLTAGE (V):

**10,70**

R = 198,1

CURRENT (mA):

**54**

**Voltage** : Shows the Maximum Voltage.

**R** : Shows the Circuit Resistance.

**Current (mA)**: Shows the current drawn by the Circuit.



**Bold Green Line** : Shows the temperature values of the electronic components.

**Thin Green Line** : Show the  $\pm$  Temperature Tolerance, i.e. If the temperature of the component is 8 °C, and the Tolerance value is 2, the green lines run between 0 °C and 10 °C.

## Power (Supply) Test - DC Voltage Current Graph

1. The Power Cable is connected to the electronic circuit supply. Red Cable (+), Black cable (-). (Figure 16)
2. The maximum Voltage and Current values which the circuit operates on are adjusted from the scroll bars. (Figure 17)
3. The "Power Test" Button is clicked to energize the electronic circuit board. The "DC Voltage - Current Graph" is generated from "0 Volt to 16 Volts in 100 mV steps. (Figure 18)
4. The "DC Voltage/Current Graph" is stored (recorded) by clicking on the "Recording" Button. (Figure 19)
5. The "Clr" Button is clicked to delete the "DC Voltage - Current Graph" from the screen. (Figure 20)

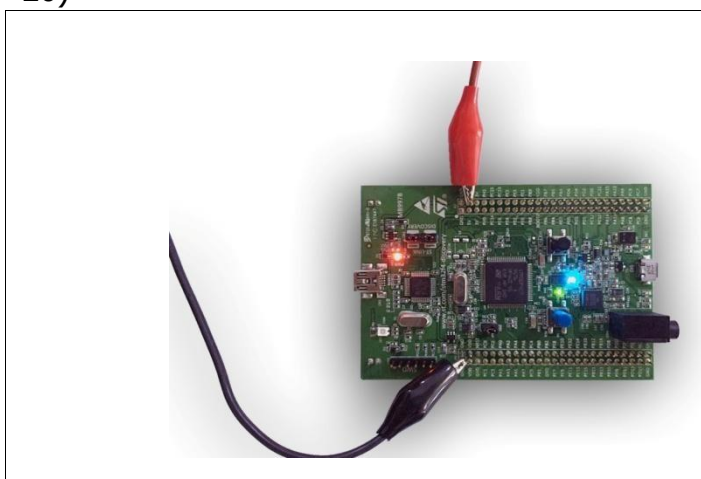


Figure 16: Connecting the Power Cables to the Circuit (Step 1)

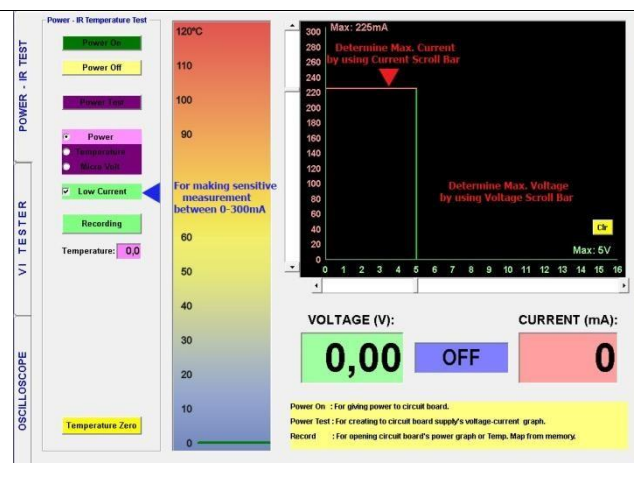


Figure 17: Adjusting the Voltage and Current (Step 2)

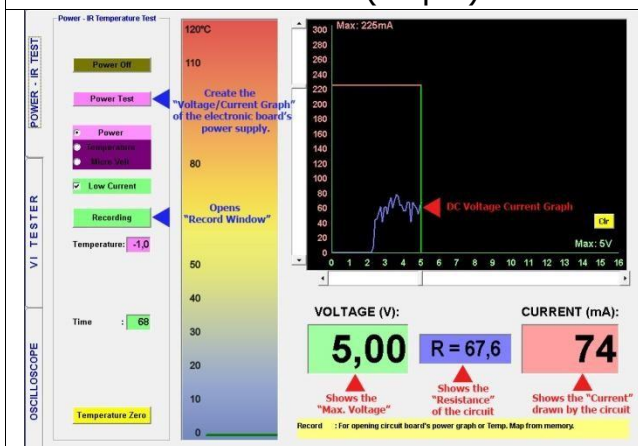


Figure 18: Generating the DC VI Graph (Step 3)

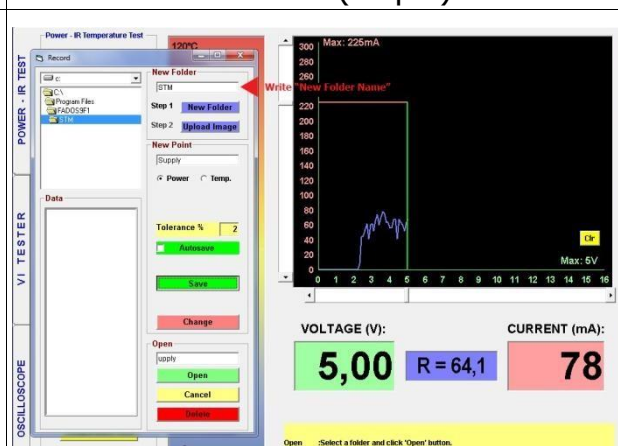


Figure 19: Recording the DC VI Graph (Step 4)

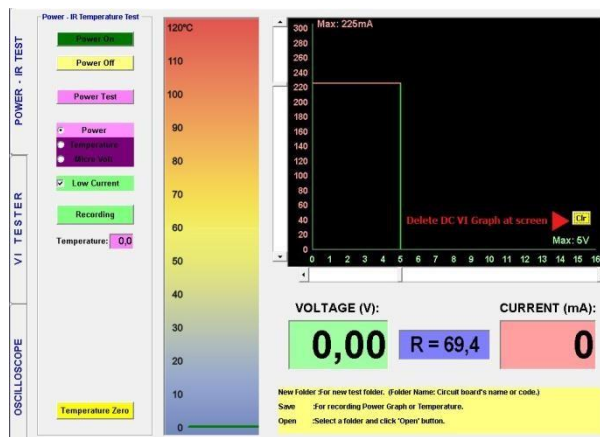


Figure 20: Deleting the DC VI Graph

## Saving the Power (Supply) DC VI Graph and Defining the Recording Window

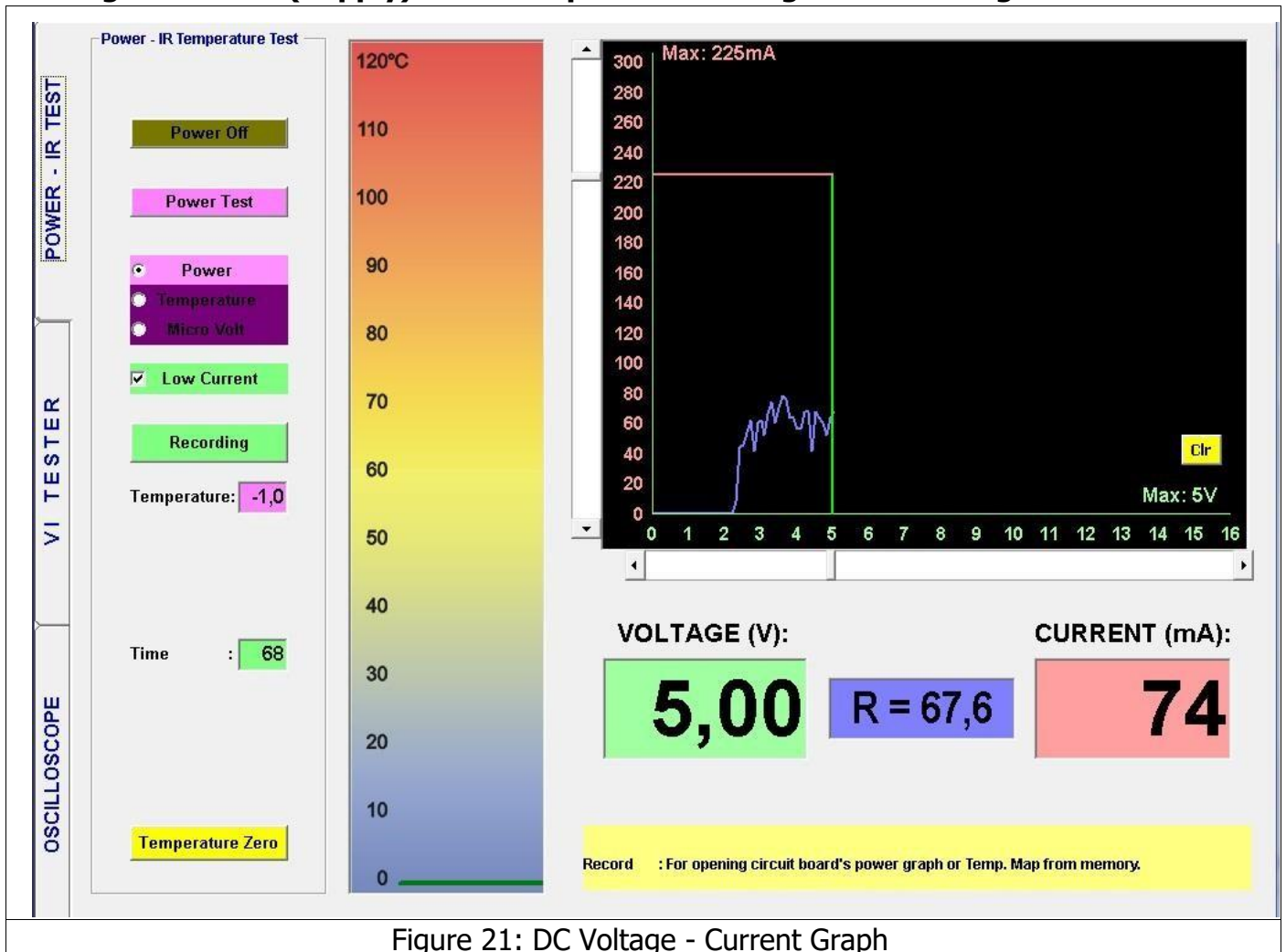


Figure 21: DC Voltage - Current Graph

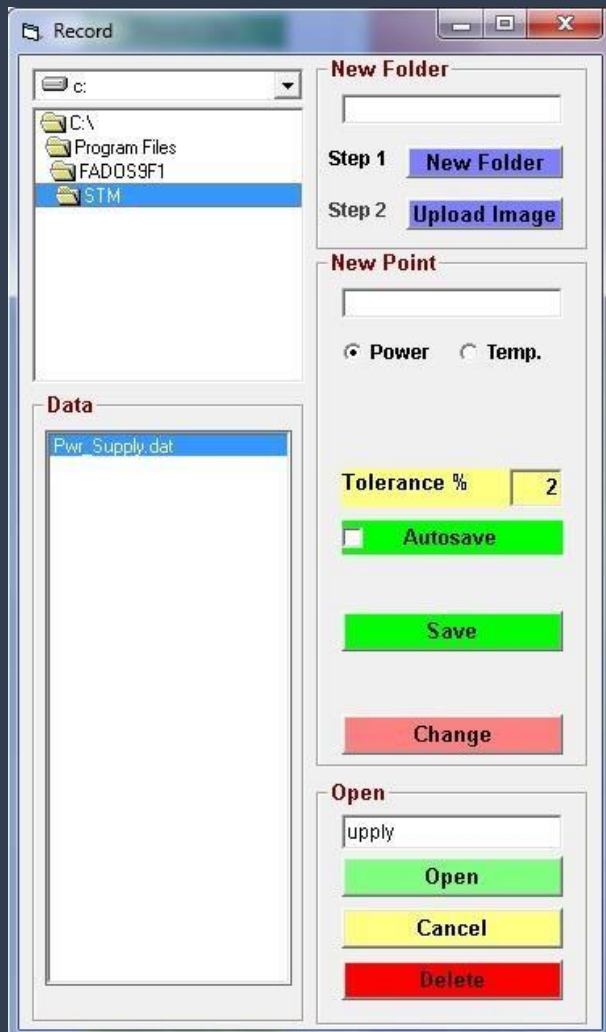


Figure 22: Recording Window

**New Folder :** Opens a folder in the computer's hard disk with the entered name to the New Folder line.

**Upload Image :** The software opens a screen for the circuit photo saved in the computer.

**New Point :** The name of the data to be saved in written.

**Power :** If the DC Voltage/Current Graph is to be saved, "Power" is selected.

**Temp. :** If the temperature value of the component is to be saved, Temp. is selected.

**Tolerance % :** Defines the tolerance range for the data to be saved.

**Save :** Saves the values for the (New point) to folder (New Folder) under name given.

**Change :** In order to change data for a test point saved before, the test point is selected from "Data" and the saved data are changed by clicking on the "Change" button.

**Open :** Opens the selected saved test data in "Data".

**Delete :** Deletes the data for the test point selected from "Data" from the computer.

**Cancel :** Closes the recording window.

**Data :** Shows the recorded data.

## Comparison of the Power (Supply) DC VI Graph with the Defective (Faulty)

### Electronic Circuit Boards DC VI Graphs

**Opening the Recorded Data :** Click on the "Recording" button to open the "Record Window". Find the file created with a new name. Select the "Pwr\_Dat." data from "Data". Open the recorded data by clicking on the "Open Button" (Figure 23 - 24).

- The Power Cable is connected to the power supply of the electronic circuit Red Cable (+), Black cable (-). (Figure 25)
- The "Power Test" button is clicked to generate the DC VI Graph of the defective or suspect board and is compared with the recorded data. (Figure 26)



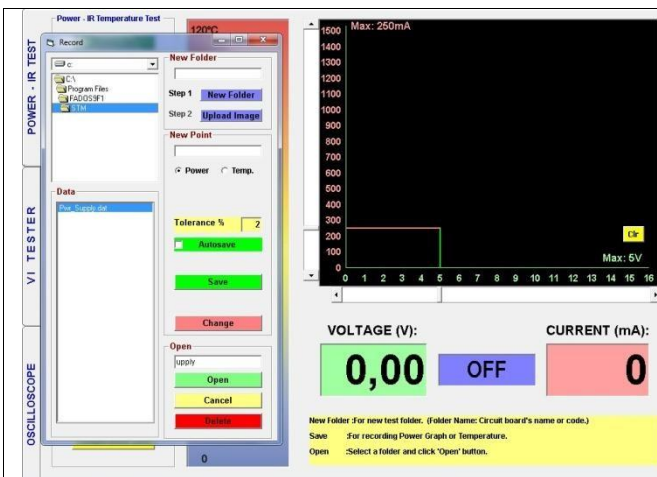


Figure 23: Opening the Recorded Data (Step 1)

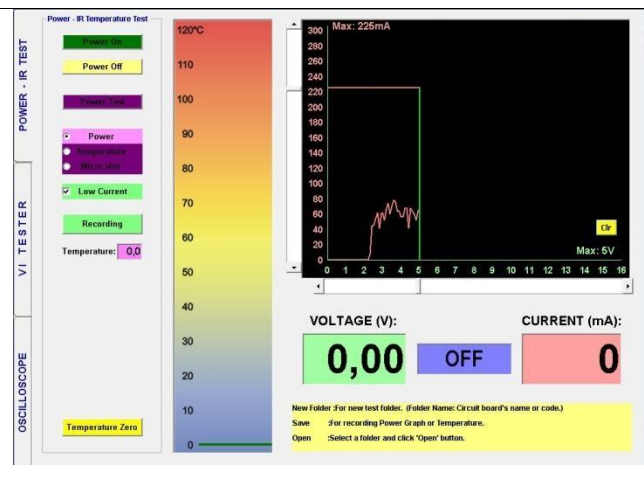


Figure 24: (Step 2)

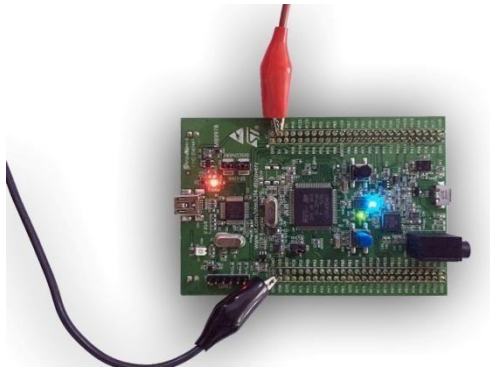


Figure 25: Connecting the Power Cables to the Circuit (Step 3)

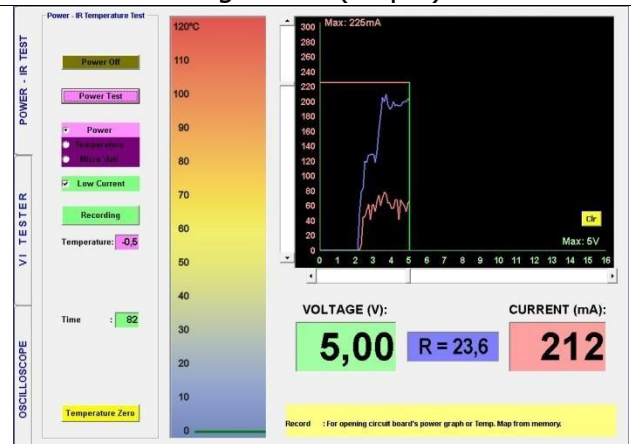


Figure 26: Comparing the DC VI Graph with the Data Saved in the Memory. (Step 4)

**Note:** The data recalled from the memory is shown in Red on the screen. The data for the electronic circuit board under test is shown in Blue.

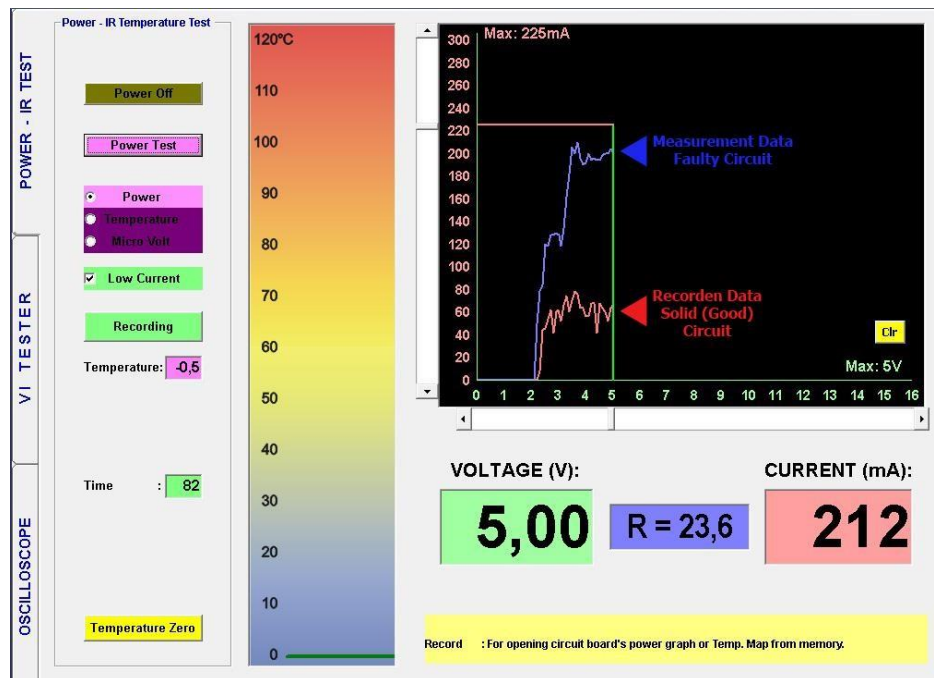


Figure 27: Comparing the DC VI Graph with the Data Saved in the Memory - Faulty Circuit Board

Power - IR Test Screen 2 graphs are displayed. If the defective electronic circuit board draws more current than the intact (working) electronic circuit board (as shown in Figure 27), this means that one or more components on the board are drawing current. The component that draws current heats up. The IR Sensor is used for diagnosing overheating components.

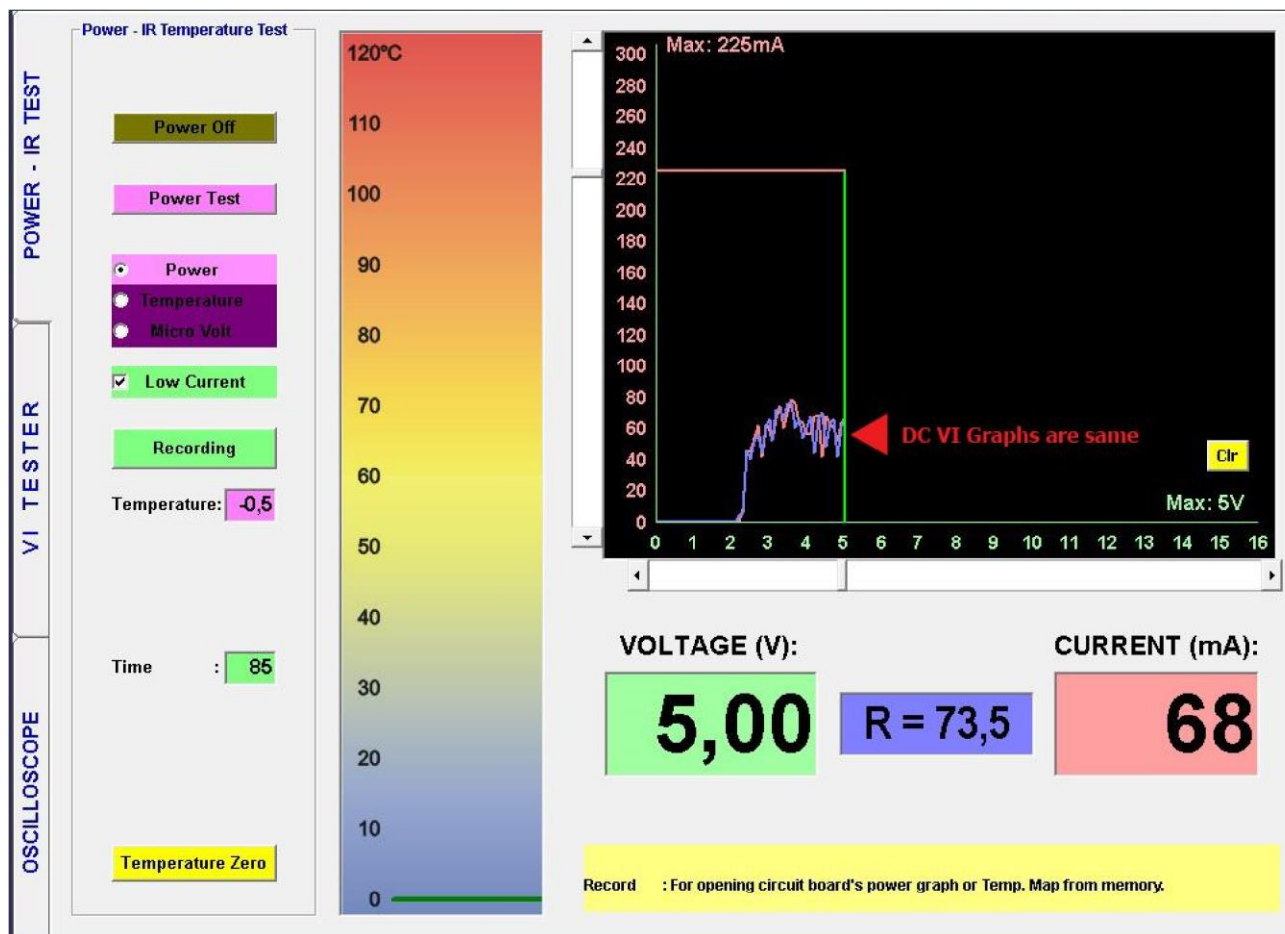


Figure 28: Comparing the DC VI Graph with the Data Saved in the Memory



If the graph of the defective or suspect board is same as the intact board (as seen in Figure 28), the “VI TESTER” screen is opened and the Analog Signal Analysis method is used to diagnose the defective components.

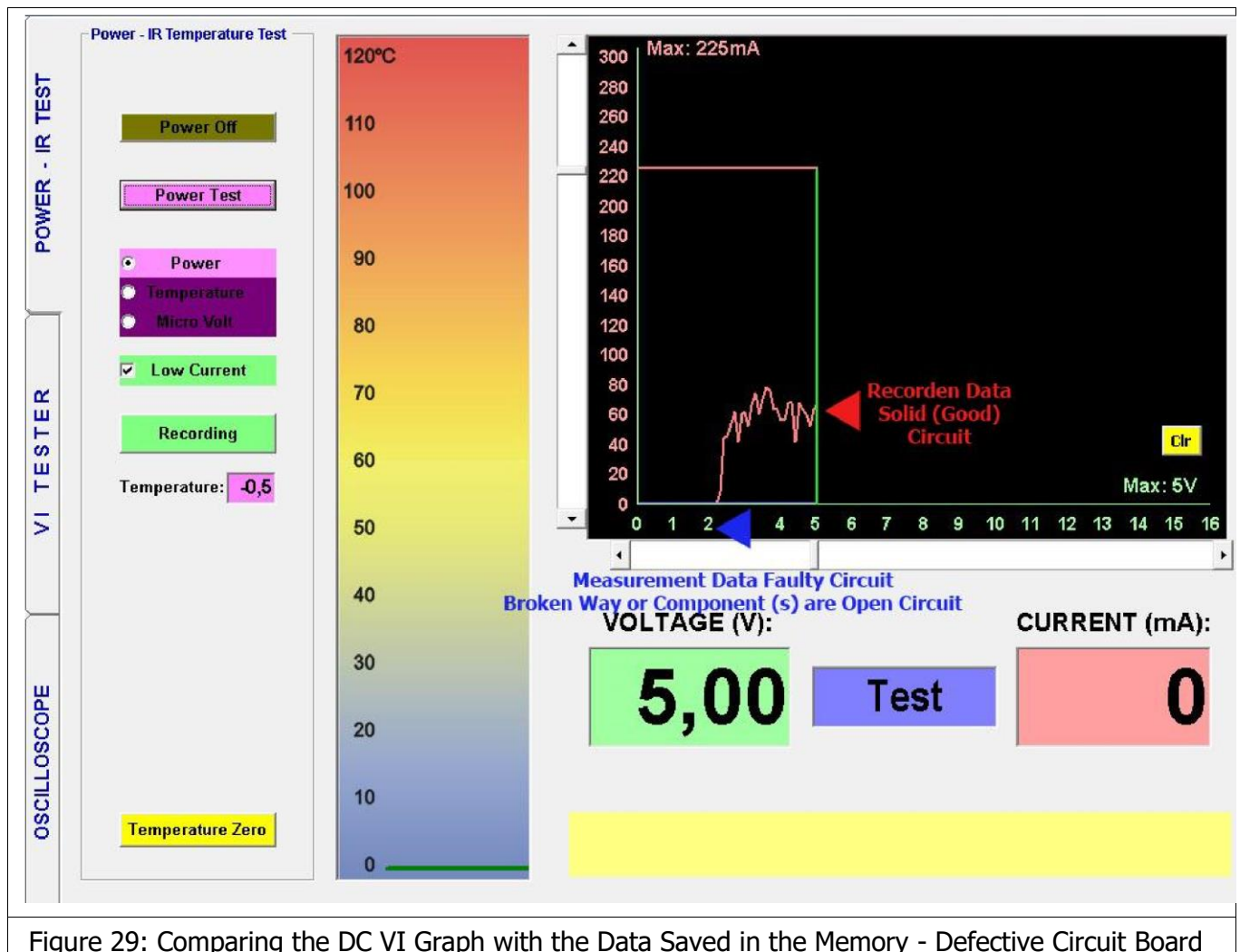


Figure 29: Comparing the DC VI Graph with the Data Saved in the Memory - Defective Circuit Board

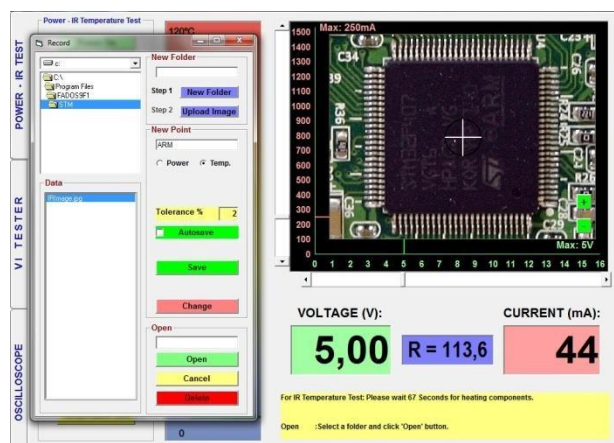
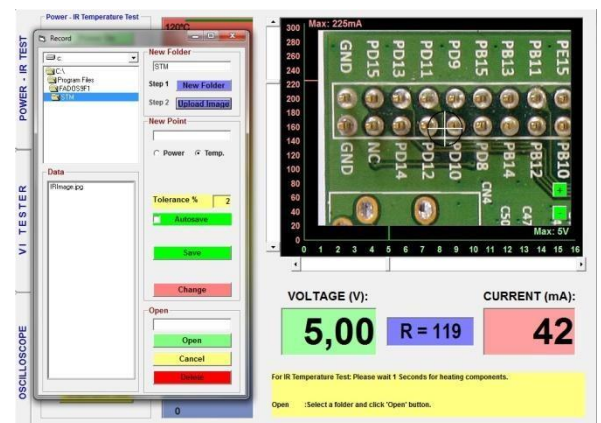
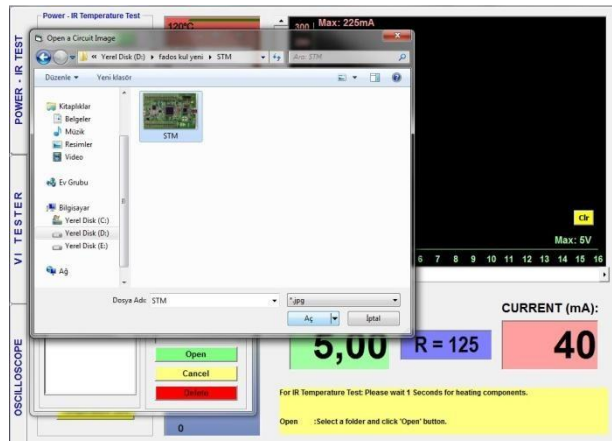
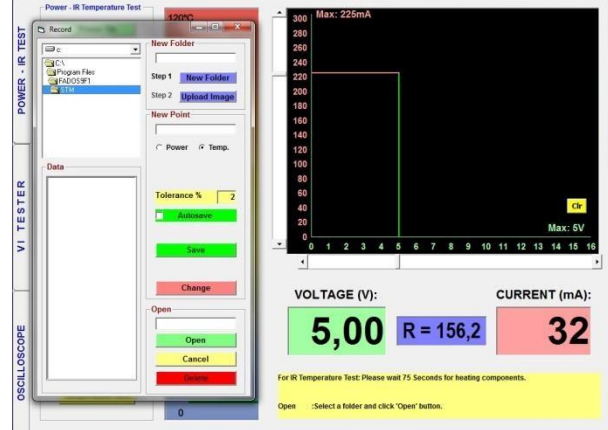
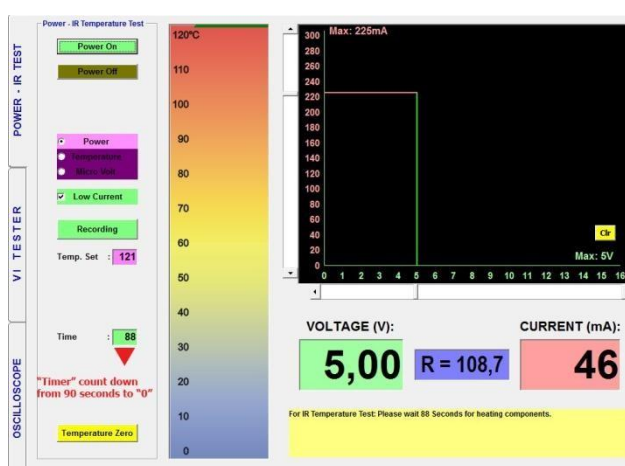
If the defective board draws less current than the intact board (as shown in Figure 29); it means there is an open circuit in the defective electronic circuit board. In such a case, the “Oscilloscope Screen” is opened to diagnose the broken circuit that cannot receive power.

## IR TEMPERATURE TEST

### Recording the Component Temperatures

One of the unique features of the TESTIT FD20 is the ability to measure the temperature of the electronic components with the Infrared (IR) Sensor and record the measurement temperature data to memory. The recorded data is compared with the defective electronic circuit board data later on to diagnose the defective current draw.





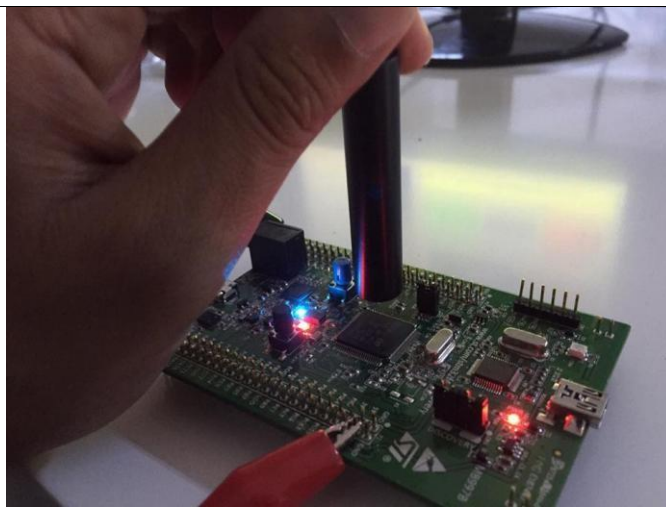


Figure 38: IR Sensor Component Temperature Measurement (Step 9)

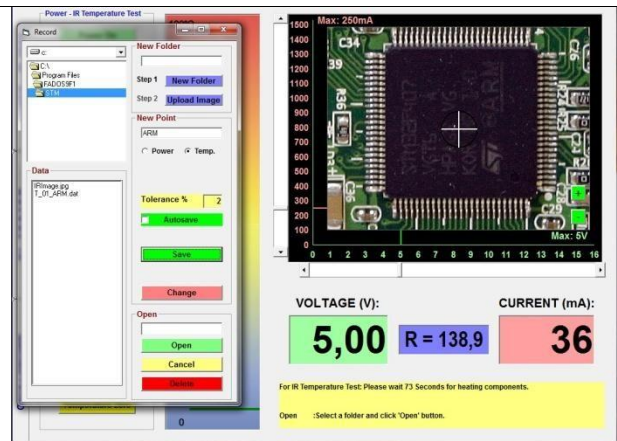


Figure 39: Recording the Temperature Data of the Component measured (Step 10)

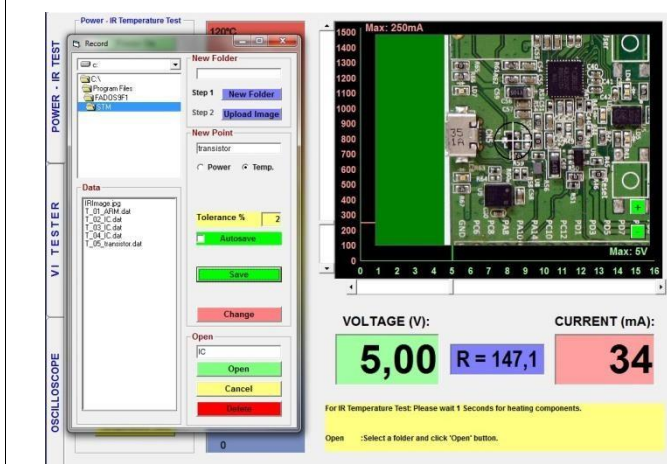


Figure 40: Recording the Electronic Material's Temperature Data

## Defective Electronic Circuit Temperature Check

1. The maximum operating Voltage and Current of the circuit is adjusted using the scroll bars. (Figure 41)
2. The Power Cable is connected to the Electronic Circuit Power Supply. Red Cable (+), Black Cable (-). (Figure 42)
3. The "Power Test" Button is clicked to energize the electronic circuit board. The "DC Voltage-Current Graph" is generated from "0 Volts to 16 Volts. Volt in 100 mV steps.  
**Note:** in the IR Temperature Test, the electronic circuit board may also be energized by clicking the "Power On" Button. (Figure 43)
4. When the Voltage limitation is reached, if the Electronic circuit board is drawing current, the "Timer" starts counting down from "90" seconds to "0". (Figure 43)
5. The temperature selection is clicked and the "Recording" Button is pushed to open the recording window. The folder created with the New name is found. The "T\_01.Dat" data is selected from



"Data". The recorded data is opened by clicking on the "Open Button" The component, whose temperature was recorded, is seen in the photo. The data for the component recorded are displayed on the left side screen. (Figure 44)

6. The IR sensor is positioned on a point on the desk (**a few mm above**) and the "Temp Zero" button is pushed. (Figure 45)
7. The IR sensor is brought over the component to be measured when the timer resets. (Figure 46)  
**Note:** Do not touch the IR sensor to the component. Measure the temperature of the components from a few mm above.
8. The temperature of the first component is measured. If the value measured is within the recorded tolerance range of the recorded data, a sound indicating conformity is emitted, and the "Next Point" is clicked to open the second recorded data. If the value measured is not within the recorded tolerance range of the recorded data, a sound indicating nonconformity is emitted and the current drawing component is thus diagnosed. If "Auto Test" is selected and the value measured is within the recorded tolerance range of the recorded data, the next recorded data is opened after a few seconds later automatically. (Figure 47)

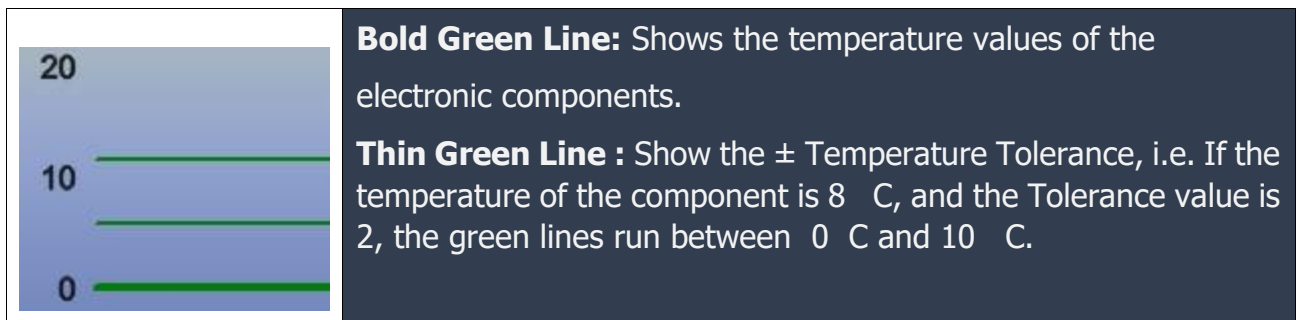


Figure 41: Adjusting the Voltage and Current (Step 1)

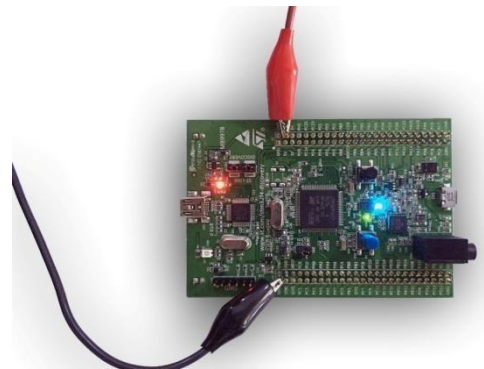


Figure 42: Connecting the Power Cables to the Circuit - Energizing (Step 2)



Figure 43: Timer 90 Seconds (Step 3)

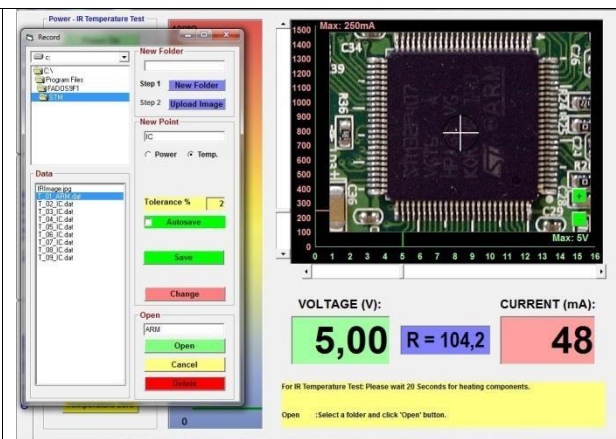


Figure 44: Opening the Recording Window (Step 4)

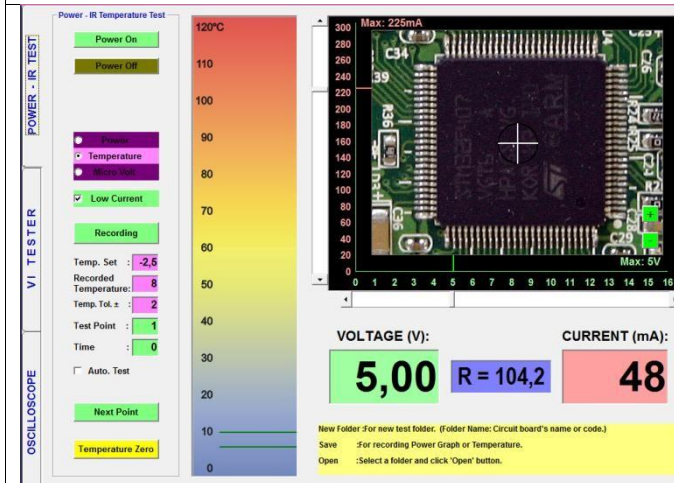


Figure 45: Opening the Recorded Data (Step 5)

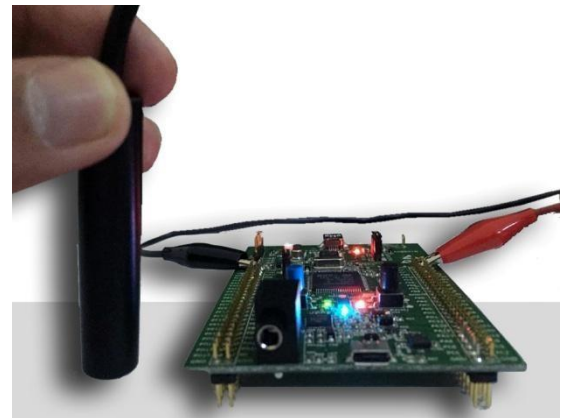


Figure 46: Resetting the IR Sensor Temperature according to the Measurement Point (Step 6)

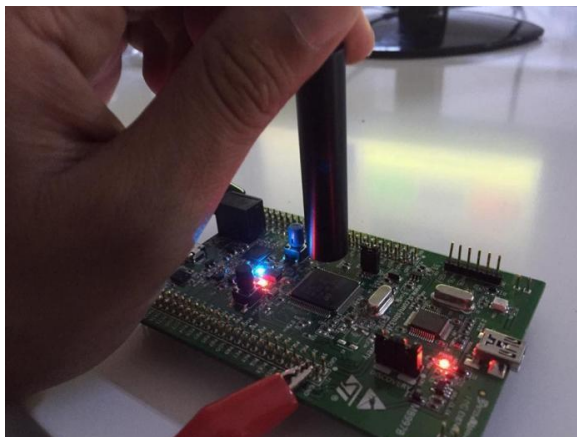


Figure 47: IR Sensor Component Temperature Measurement (Step 7)

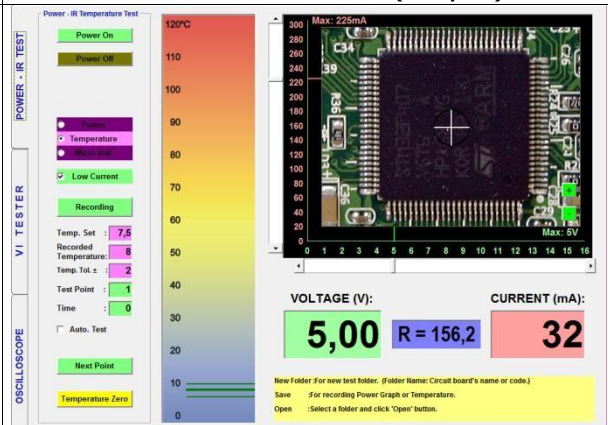
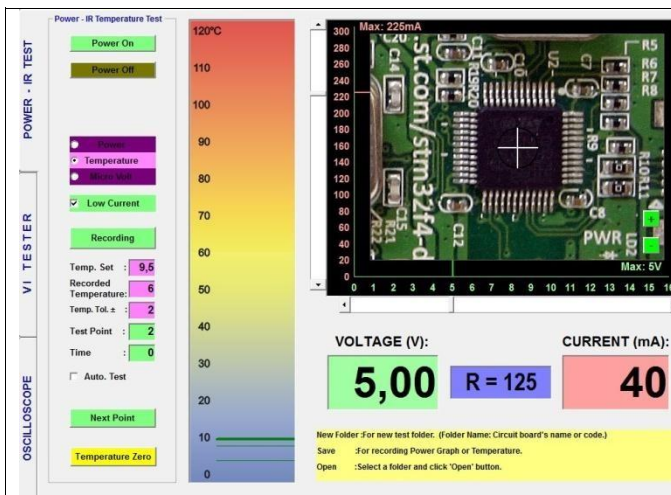


Figure 48: Comparing the Temperature Measured with the Data Saved in the Memory (Step 8)



If the value measured is within the recorded tolerance range of the recorded data, a sound indicating conformity is emitted, and the “next point” is clicked to open the second recorded data. If the value measured is not within the recorded tolerance range of the recorded data, a sound indicating non-conformity is emitted and the current drawing component is thus diagnosed.

Figure 49: Comparing the Temperature Measured with the data Saved in the Memory (Step 8)

## Micro - Voltage



Micro - Volt: The TESTIT FD20 may also be used for micro - volt measurements. Select the Micro-Volt option to open the Micro Voltage screen. Connect one of the probes of the Oscilloscope to the IR connector and conduct the microvolt measurement. You can measure the values below Maximum 2,5  $\mu$ V.

Figure 50: Micro Volt



## VI TEST - FAULT DETECTION SCREEN FEATURES

The VI Tester button is clicked in the TESTIT FD20 program to open the VI Tester screen.

The TESTIT FD20 operates by injecting a current-limited sinusoidal wave to the electronic circuit board through a series resistor showing the Voltage/Current graph on the computer screen. The Voltage/Current rate is called "**V/I**", but is also known as the **Analog Signal Analysis** (Analog Signature Analyze – ASA) or **Impedance Test**. The Current–Voltage Analysis (Analog Signal Analysis) is a test conducted without applying power to the electronic circuit board and is used to eliminate the failures in electronic circuit boards.

In addition to the above features, the computer software analyzes the Voltage/Current graph and shows the equivalent circuit diagram of the contact point. The values of the associated components and those features are aimed at informing the user as an aid in troubleshooting the failures easily. With the TESTIT FD20, the defective component is identified from the VI graph and the equivalent circuit diagram is intended for informational purposes only. Finding the defect just by looking at the equivalent circuit diagram may not always be possible.

**Note:** While comparing two electronic circuit boards, there may be small differences in the circuit's damage even if the graphs may be identical. This does not indicate a defect in the board compared; the main purpose is to observe differences between the VI graphs. The electronic circuit board under test might still be considered as good.

While conducting a V/I graph screen test, connect the Clip lead or COM (Crocodile) probe to the electronic circuit board's chassis. Touch the other probe to the point to be tested with the device. The device applies a signal to the point touched through the probe and the software runs a scan from negative voltage to positive voltage.

For example, if a 6V test voltage is selected, the TESTIT FD20 applies a sinusoidal signal from -6V to +6V. The VI graph of the Electronic component is displayed on the screen. Each electronic material has its own unique characteristic curve (VI graph).

All the keys to be used for trouble shooting are placed on the left hand side of the panel.



Figure 51: Fault Detector - VI Tester Screen

**Channel 1 - 2**

☐ Automatic

1 V    2 V

6 V

12 V

24 V

Very Low Frq.

Low 2 Frq.

Low 1 Frq.

Test Frq.

High Frq.

Low    Med1

Med2    High

☒ Comparison

☐ Capacitor Test

☐ T.T.T. FET IGBT

**Recording**

Memory Save - Test

**Recording**

Test Point: 1

Point: R1

<---    --->

Tolerance (%) 3

☒ Gr.1

6 V

T. Fr.

H.Cur.

1G

**Reference: Ch1**

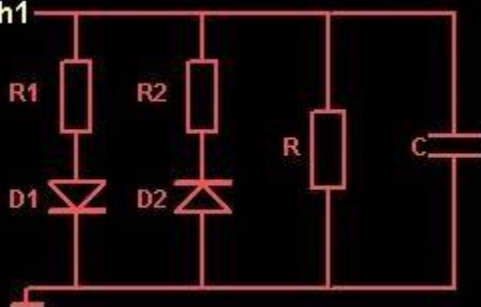
R : 11,6 K

D1: 0,6 V

R1: 1,56 K

D2: 0,55 V

R2: 3,43 K



**Channel 1 - 2** : Used for selecting the Channels. The Channel button can display only the Channel 1, Chanel 2 or both channels simultaneously on the screen. Using Channel 1 and 2 at the same time is recommended.

**Automatic** : When this feature is selected, software determines the most suitable of the Voltage, Frequency and Current stages according to the characteristics of the point touched automatically. Click on automatic again to disable the automatic mode.

**Voltage Stage(s)** : The voltage to be applied to the board is selected by manually setting the  $\pm 1$  V,  $\pm 2$  V,  $\pm$  V,  $\pm 12$  V,  $\pm 24$  V stages from the voltage stage selector. Only one voltage may be selected at a time for a given test.

**Frequency Stage(s)** : The Frequency to be applied to the board is selected by manually setting the Very Low Frequency, Low 2 Frequency, Low 1 Frequency, Test Frequency, High Frequency stages from the Frequency stage selector. Only one Frequency may be selected at a time for a given test.

**Current Stage(s)** : The current to be applied to the board is selected by manually setting the Low Current, Medium1 Current, Medium2 Current, High Current stages from the Current stage selector. Only one Current may be selected at a time for a given test.

**Comparison** : We can compare various points on the intact and defective boards when this feature is selected.

**Capacitor Test** : We can measure the internal resistance of the capacitor and determine its quality when this feature is selected.

**T.T.T. FET IGBT** : When selected, this function determines the type of the T.T.T. FET IGBT etc. semi-conductors.

**Recording** : Opens the Recording window. The recording window menu is used for Recording or retrieving the recorded data.

**Test Point** : Shows the serial number of the point under test.

**Point** : Shows the name or code of the point under test.

← : Opens the previous test point.

→ : Opens the next test point.

**Tolerance %** : Defines the tolerance range for the test point. It can be changed by the user.

**Graphs for 3 different settings as Gr.1:** Gr.1, Gr.1 and Gr.3 (voltage – frequency – current) can be selected, which allows switching rapidly.

**1G, 2G, 3G** : 1, 2 or 3 graphs of different settings can be displayed on the screen simultaneously.

**Reference:** When the data is recorded in the memory, the data in Channel 1 (reference) are is recorded inmemory. Showing the equivalent circuit diagram and values of the electronic material under test.

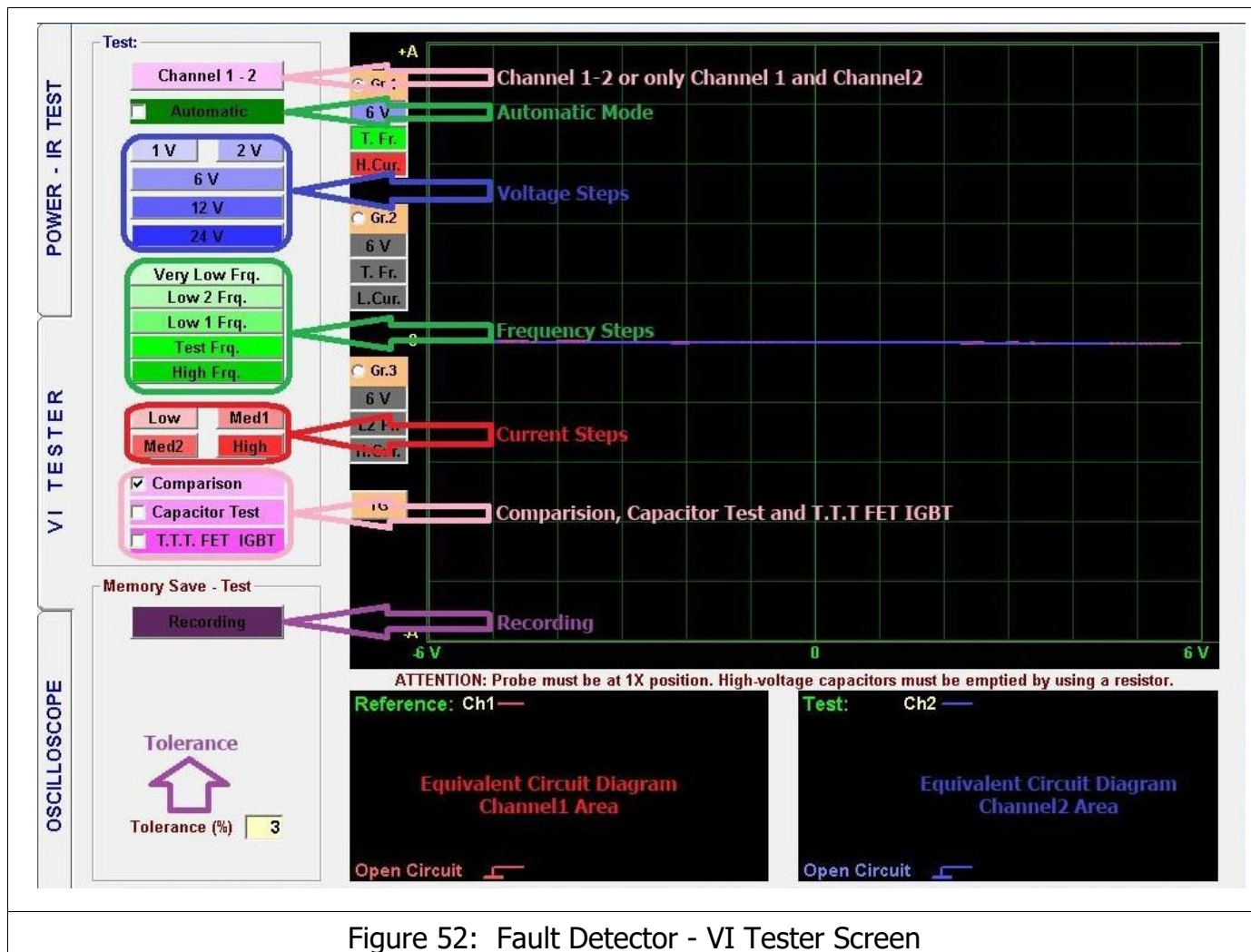


Figure 52: Fault Detector - VI Tester Screen

## OPEN CIRCUIT - SHORT CIRCUIT

**Open circuits** are like a broken road between the component under test and the chassis; Causing zero current flow and maximum voltage drop between the test terminals.

The zero current and maximum voltage is represented with a straight line running from the left side of the screen to the right side (Figure 53 Channel 2 Open Circuit).

The VI Tester screen is divided into small squares of same size. (as shown in Figure 53). The squares on the horizontal axis provide information about the test voltage selected. For example, if a 6 volt test voltage is selected, each square represents 1 volt. This is explained in detail later.

**Short circuit** (Figure 53 Channel1 Short Circuit) causes maximum current flow and zero voltage drops between the test terminals.

The Vertical Axis provides information on how much current the electronic material draws. While comparing, the defective component may conduct the same voltage as the intact component and may draw more or less current. We can easily see this by looking at the vertical axis.

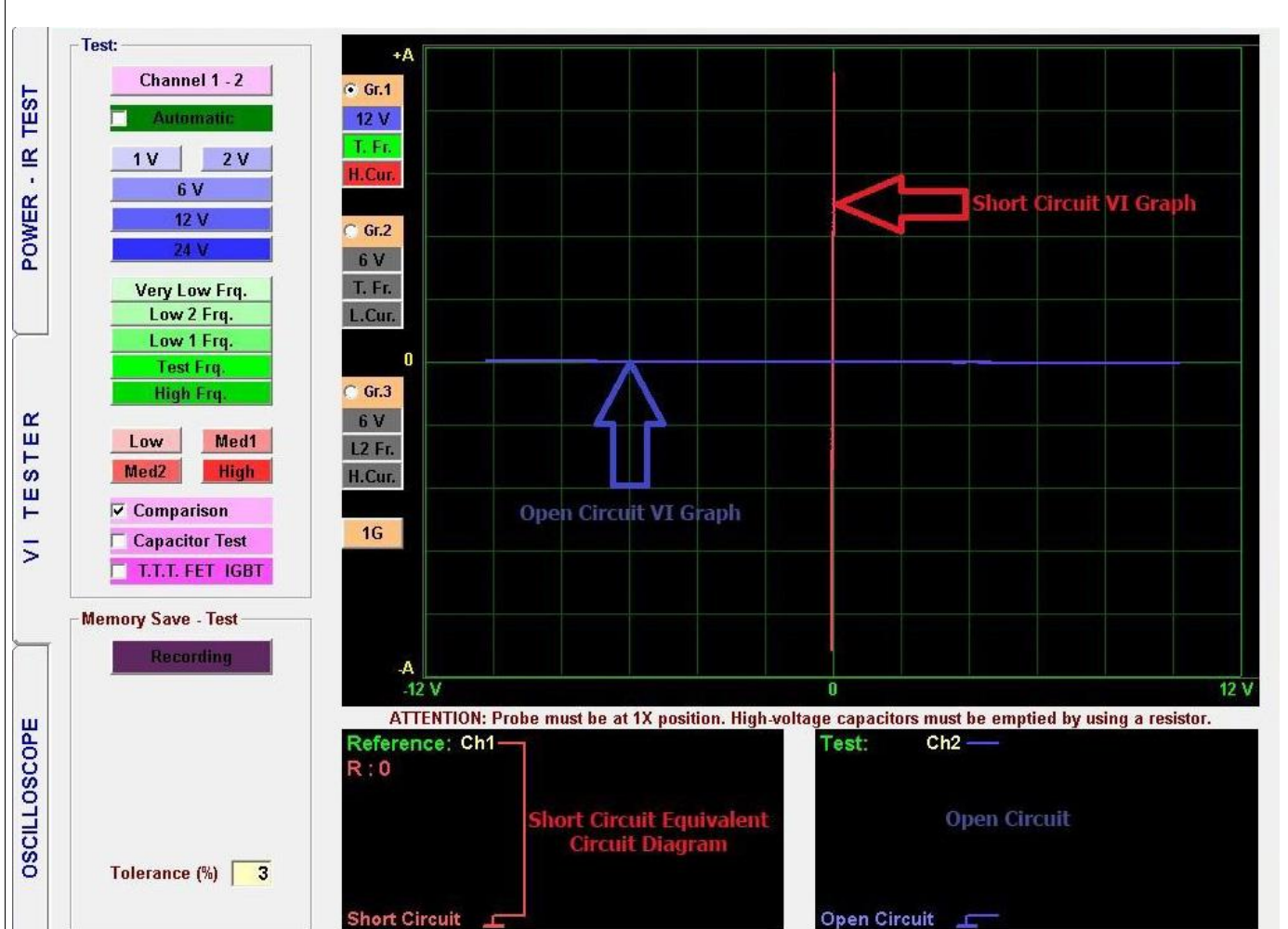


Figure 53: Short Circuit Graph (Channel1) - Open Circuit Graph (Channel2)



Figure 54: Short Circuit (Channel1) - Open Circuit (Channel2)

If we connect the Channel1 probe to the crocodile (Com), a short circuit is created between Channel1 and crocodile.

Moreover, we can discern which probe is probe is Channel1 and Channel2 by making a short circuit.

## Voltage Selection

The TESTIT FD20 test voltage stages are  $\pm 1V$ ,  $\pm 2V$ ,  $\pm V$ ,  $\pm 12V$  and  $\pm 24V$ . The TESTIT FD20 applies a current-limited sinusoidal test voltage in the above test voltage values to the point selected on the electronic circuit board through a series resistor.



VI Test screen is also divided in to squares of the same size. The squares on the horizontal axis provide information on the voltage ranges.



Figure 55: If the Test Voltage 1V, Each Square Represents 0,5V.



Figure 56: If the Test Voltage 2V, Each Square Represents 0,5V.



Figure 57 : If the Test Voltage 6V, Each Square Represents 1V.



Figure 58 : If the Test Voltage 12V, Each Square Represents 2V.



Figure 59: If the Test Voltage 24V, Each Square Represents 4V.

Test Voltage	Square Voltage
±1V	0,5V
±2V	0,5V
±6V	1V
±12V	2V
±24V	4V

## The Characteristic VI Graphs of The Main Electronic Components

All the VI graphs are created by connecting one or more main electronic components to each other in parallel or in series. The main electronic components are the **Resistor** (Figure 60), **Capacitor** (Figure 61), **Inductor** (Figure 62) and **Diode** (Figure 63). The Electronic components respond differently to the test signal of the VI Test device.

The VI graph obtained by connecting the Electronic components in parallel or series is composed of the VI graphs of the electronic components connected on the electronic circuit board. For example, a VI graph composed of a resistor and capacitor is a combination of the VI graphs of the resistor and capacitor.

The **Resistor** VI graph is always a straight line between 0 and 90 degrees to the X axis. The **Capacitor** graph is an ellipse or a circle. The **Inductor** graph is elliptical or circular; due to the resistance of the wires in the inductor, the effect of the resistors is also observed in the graph. The semiconductor **Diode** graph appears as one or more straight lines with a 90 degree angle in between.

All the electronic components can be tested by starting from that basic information.

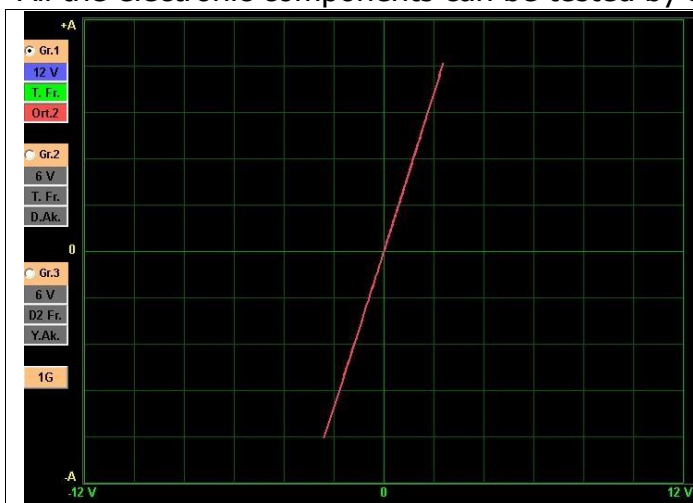


Figure 60: Resistor VI Curve

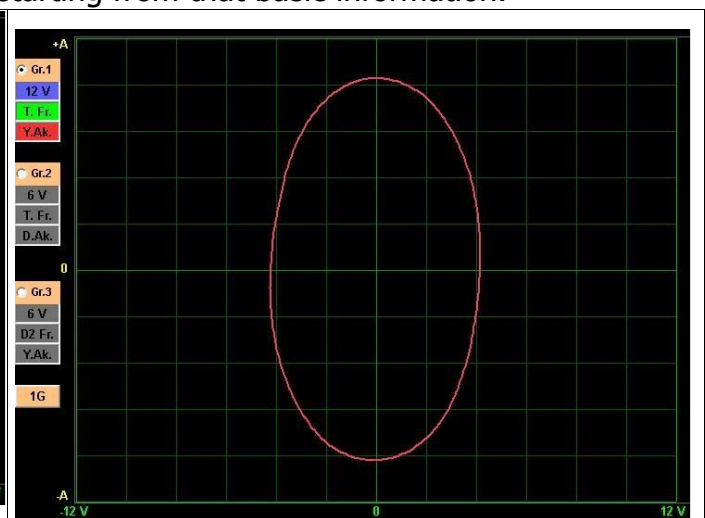


Figure 61: Capacitor VI Curve

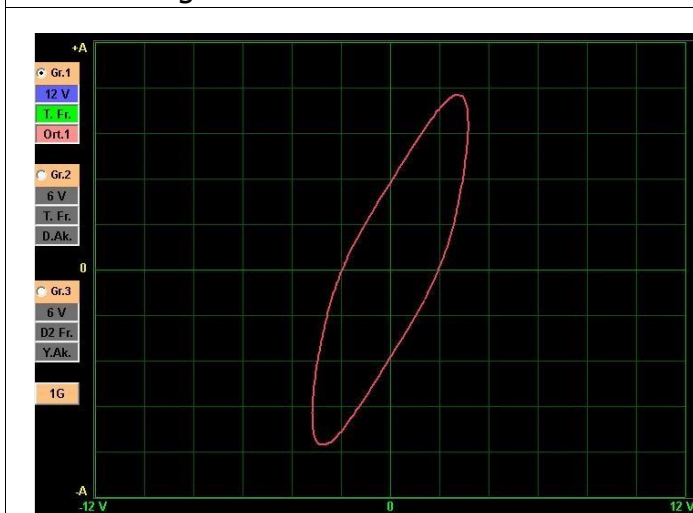


Figure 62: Inductor VI Curve



Figure 63: Diode VI Curve

## Resistor VI Graph

According to the Ohm's Law, the Resistance is Voltage over Current. In the Analog Signal Analysis test the resistor graphs are represented as a visualization of Ohm's Law. Figure 64 shows the typical signal, equivalent circuit and values for a resistor. The amount of voltage applied to the resistor is shown along the horizontal axis and the current induced is shown along the vertical axis. Because the Voltage and Current is linear according to the Ohm's Law, the resistor's graph is represented by a straight line. The Resistor graph makes a "0 - 90" degree angle from the horizontal axis. The resistor graph curve varies according to the current stages of the TESTIT FD20 device or in connection with the value of resistor.

As the Resistor value increases, the angle of the Voltage/Current curve with the horizontal axis is reduced (approaches to "0" degree).

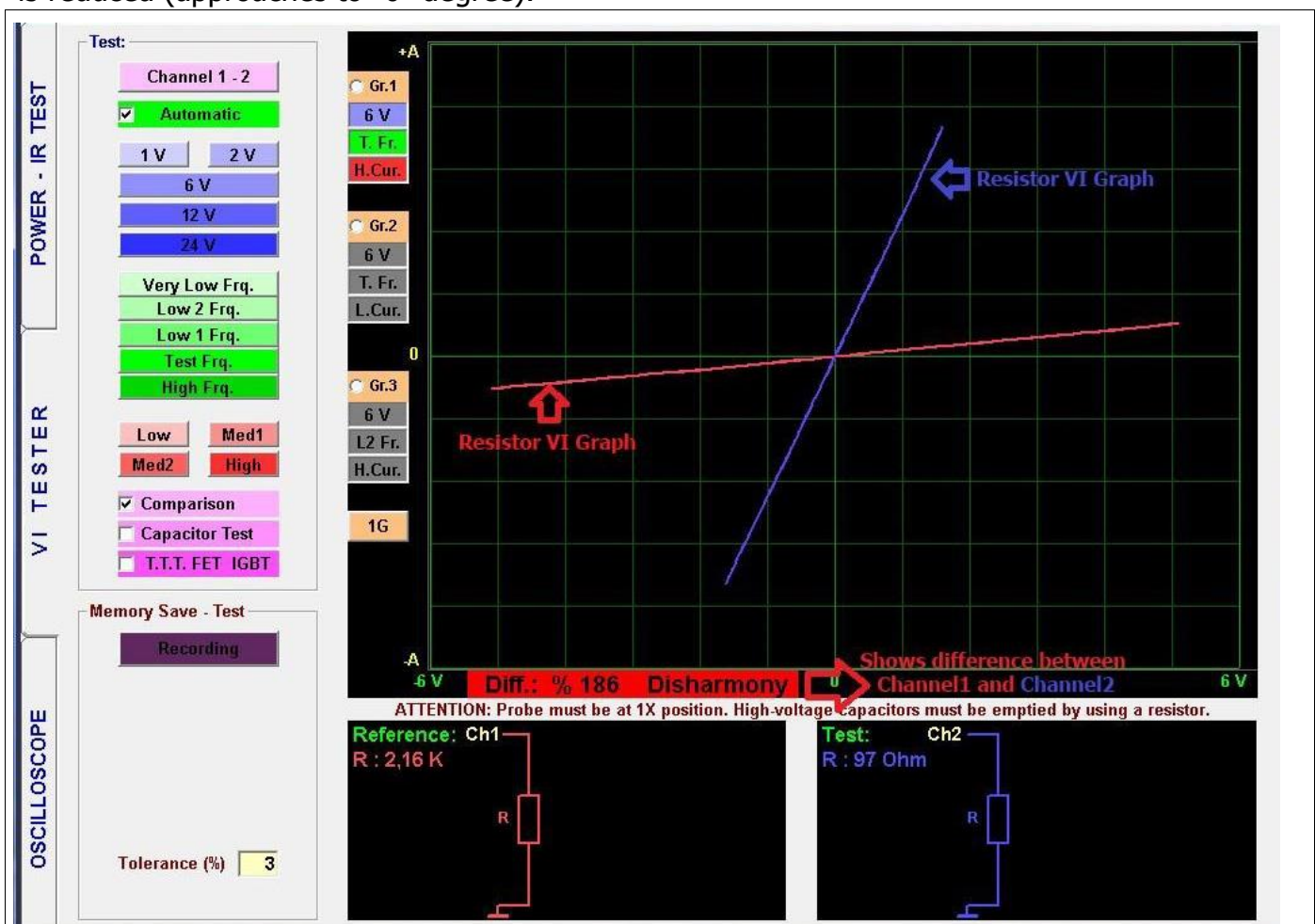


Figure 64: Resistor VI Graph, Equivalent Circuit Diagram and Value Measurement (Channel1 Red - Channel2 Blue)

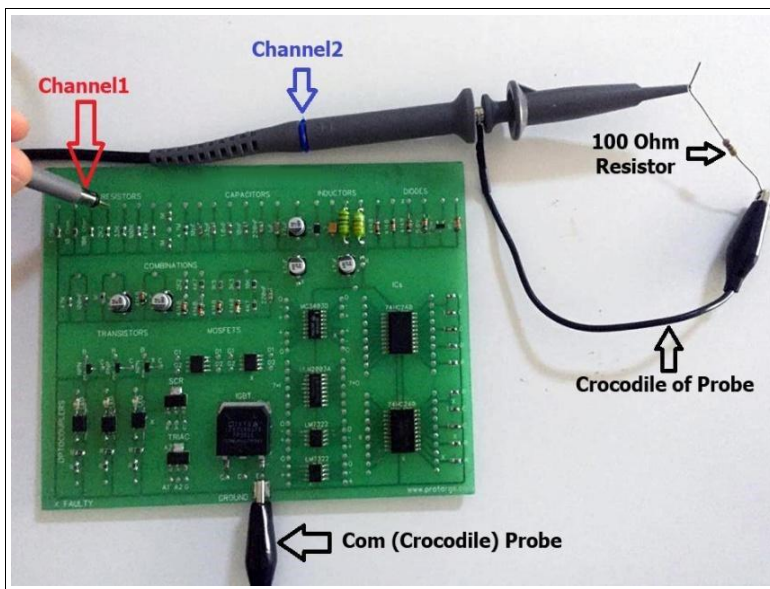


Figure 65: Measuring a 2,2 K $\Omega$  resistor in the Electronic circuit, and Measuring a 100  $\Omega$  Resistor

While measuring a resistor outside the circuit; connect to the crocodile to one foot (side) of the resistor and touch the probe to the other foot (side).

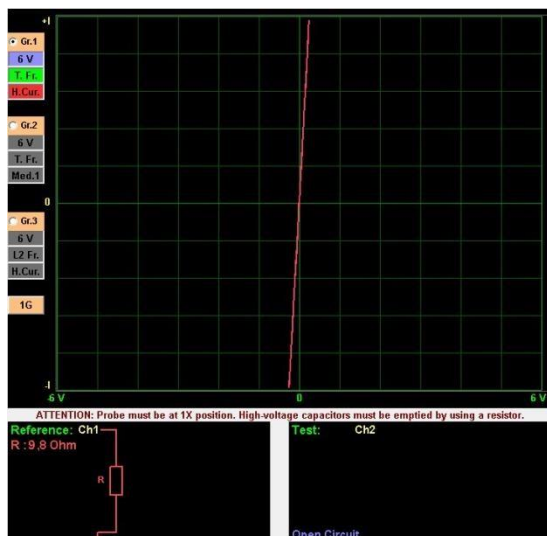


Figure 66: 10  $\Omega$  Resistor VI Graph

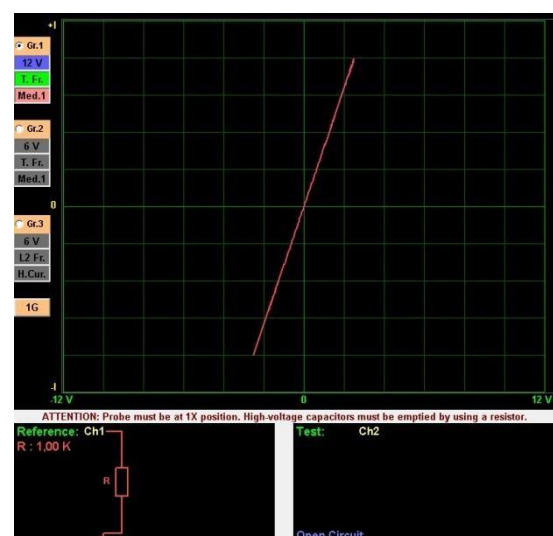


Figure 67: 1 K $\Omega$  Resistor VI Graph

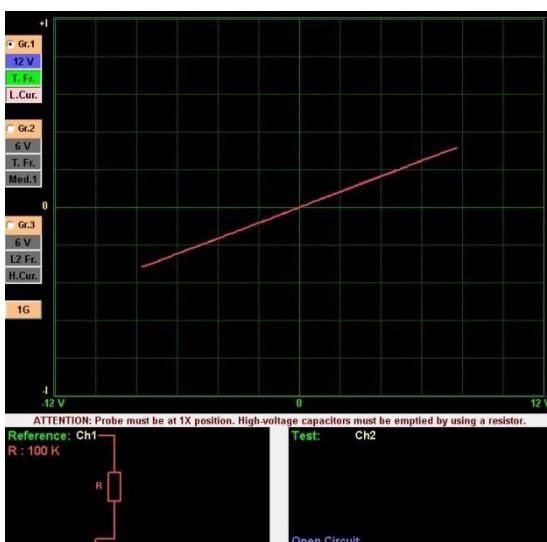


Figure 68: 100 K $\Omega$  Resistor VI Graph

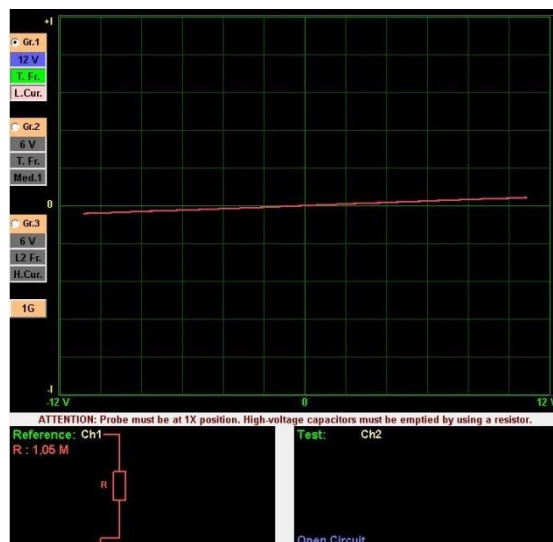


Figure 69: 1 M $\Omega$  Resistor VI Graph



The Low value resistors graph is very close to the vertical axis. While testing a low value resistors use the High Current Stage. The High value resistors graphs is very close to the horizontal axis. Therefore, while testing a high value resistors use the Low Current Stage. Since the Resistor is not a reactive component, the voltage and frequency stages do not change the resistor VI graphs.

## Capacitor VI Graph

The Capacitor is an energy storing reactive component. Therefore, the VI graph is not a straight line like the resistor graphs. When the voltage is zero in a capacitor, the current is maximum and when the current is zero, the voltage is maximum. A phase difference occurs in the voltage and current flows through the reactive device. Capacitive components create a circular or elliptical graph.

The width of the ellipse changes depending on the value of capacitor and the test stages of the TESTIT FD20. Because the capacitor analog signal graph is a function of the capacitive reactance frequency it changes when the test frequency is changed.

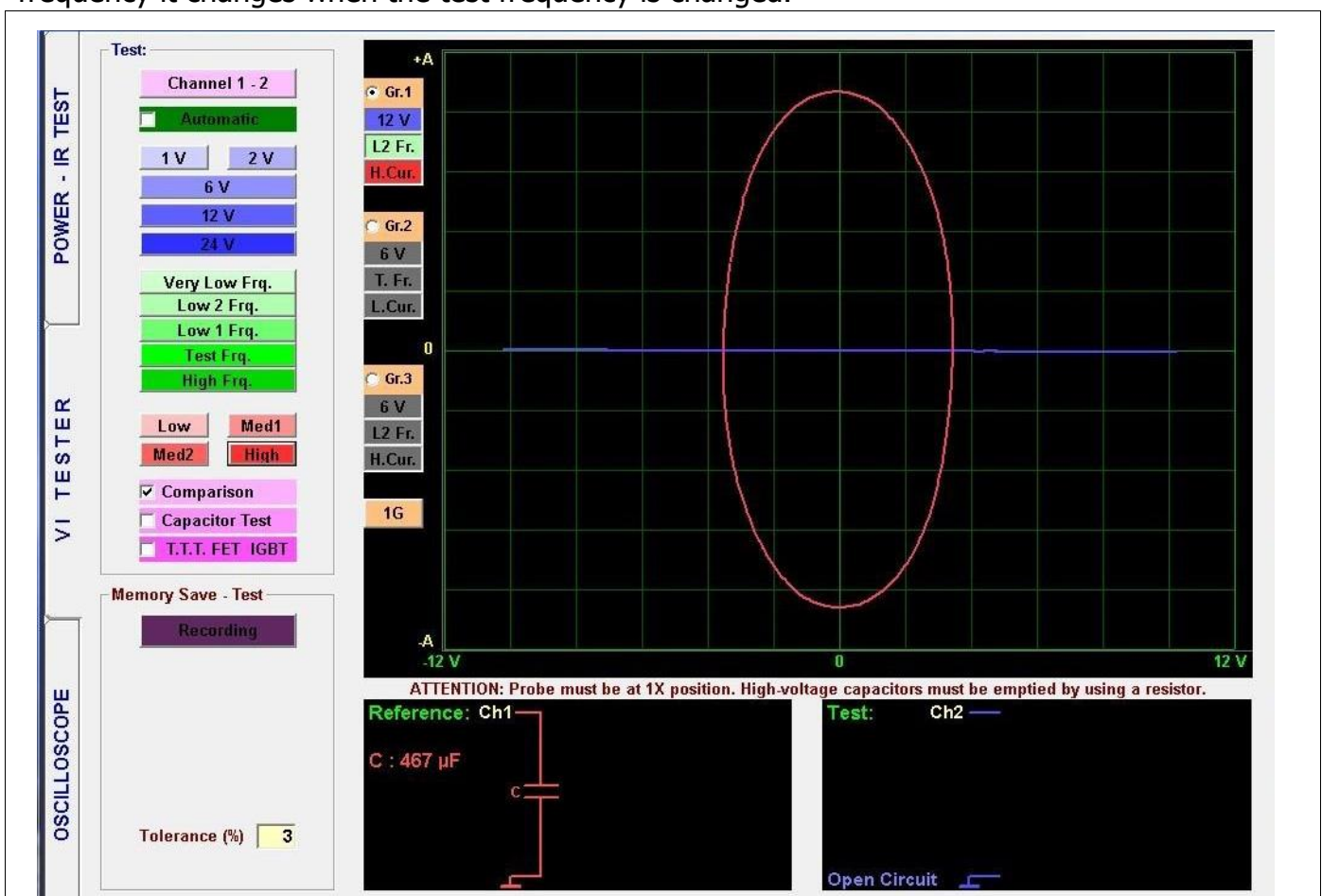


Figure 70: Capacitor VI Graph, Equivalent Circuit Diagram and Value Measurement (Channel1 Red - Channel2 Blue)



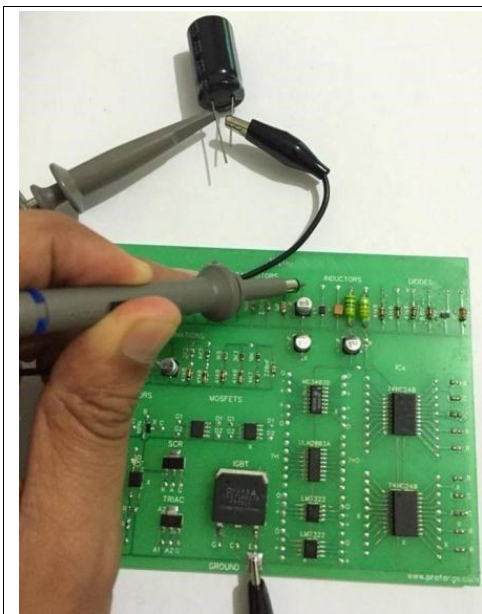


Figure 71: Measurement of a capacitor inside and outside of the circuit

While measuring the capacitors outside the circuit, connect the Clip lead to one foot and the touch the probe to the other foot.

The Figures 72, 73, 74 and 75 show the Current/Voltage (VI) graphs, equivalent circuit diagrams and values for the capacitors.

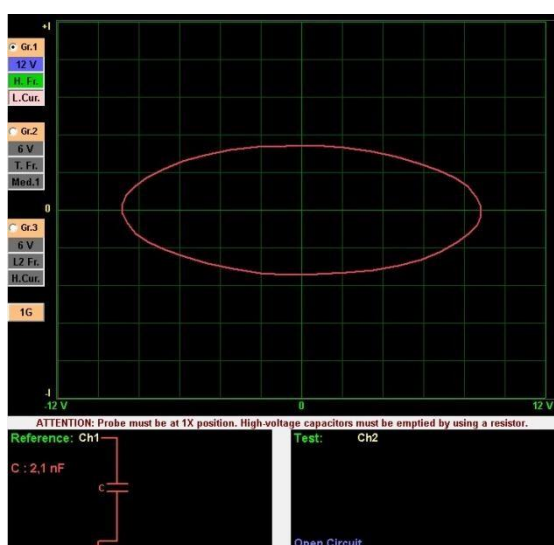


Figure 72: 1.8 nF Capacitor VI Graph

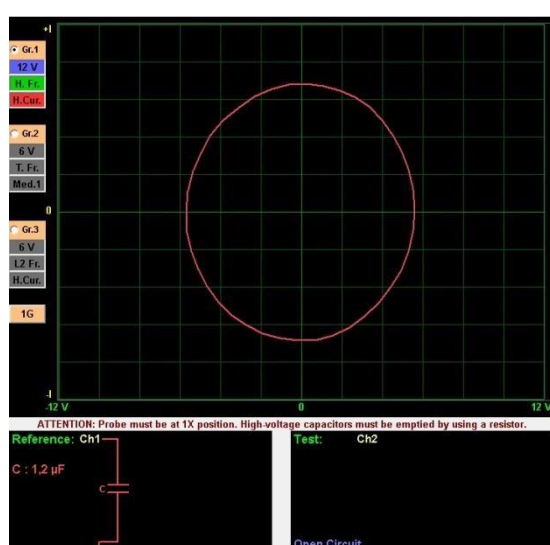


Figure 73: 1 μF Capacitor VI Graph

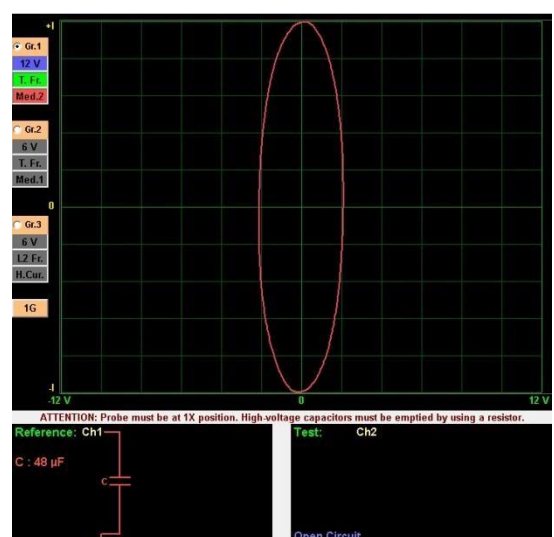


Figure 74: 47 μF Capacitor VI Graph

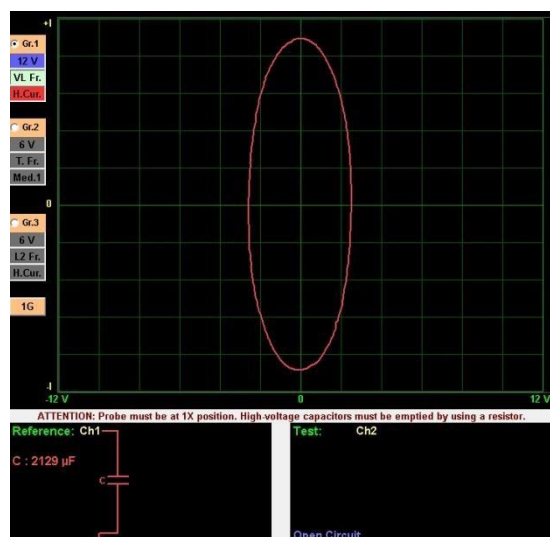


Figure 75: 2200 Capacitor VI Graph

The Capacitors should be tested after discharging. Test the Low value capacitors at the Low Current Stage and High Frequency. The VI graph of the Medium value capacitors is an ellipse close to a circle. The VI graph of the High value capacitors is close to the vertical axis. Test the high value capacitors at high current. If the Capacitor value of the capacitor is very high, decrease the frequency.

**Note 1:** Since the frequency stage drops while testing the High capacity capacitors, the graph appears on the screen with a 1 second delay. If a delay occurs in the graph during an in-circuit test, it shows the presence of a high capacity capacitor in the circuit tested.

**Note 2:** High Frequency stage uses at only 6 Voltage stage.

## **CAPACITOR (QUALITY - FAILURE CHECK) CAPACITY TEST - RC CIRCUITS VI GRAPHS**

### **Capacity Test**

Capacitor failures are caused by leaking. As a result, the capacitor acts as if a resistor is connected in parallel. The quality of the leaky capacitors is decreased.

The leaky capacitors can be identified easily thanks to the capacity test characteristics of the TESTIT FD20.

For conducting capacitor quality and failure test, the active probe is connected to the anode (+) or cathode (-) pole and the chassis probe is connected to the cathode (-) or anode (+) pole of the capacitor. Then the "**Capacitor Test**" is clicked from the test characteristics menu and a nearly linear graph appears on the screen. The closer the graph is to the X axis, the higher the quality of the capacitor. But, if the graph approaches horizontal axis too much, it means that the quality of the capacitor is reduced, leaking or defective. Leaks are very common especially in electrolytic capacitors. Disconnecting one foot of the capacitor from a circuit effectively means having removed the capacitor, allowing the capacitor test to be easily applied.

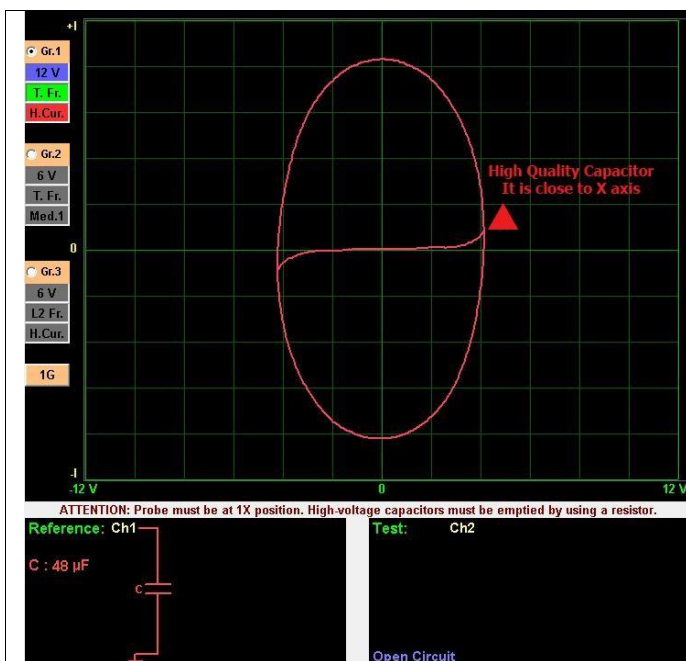


Figure 76: High Quality Capacitor

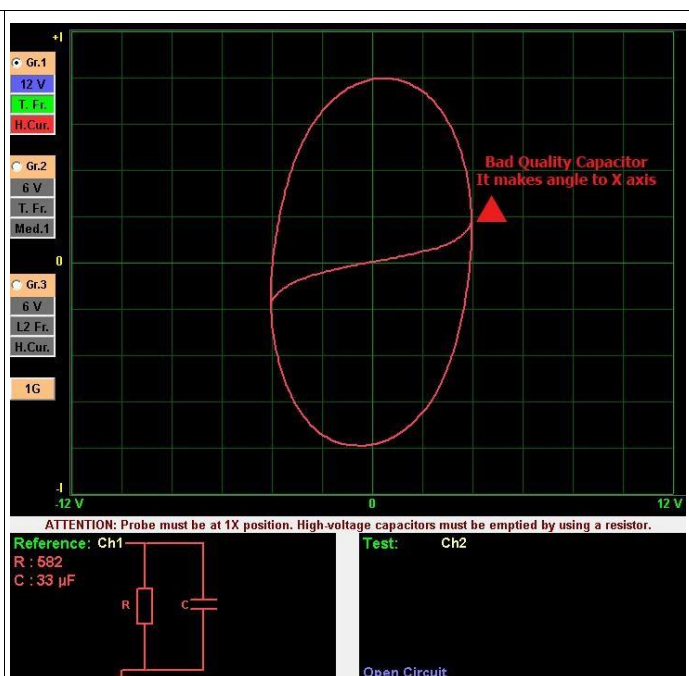


Figure 77: Low Quality Capacitor

## RC Circuits VI Graph

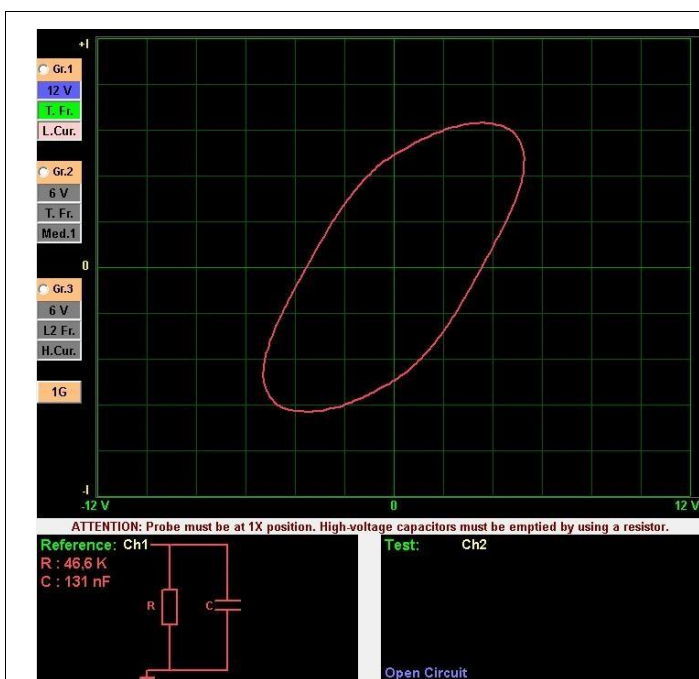


Figure 78: Capacitor - Resistor Parallel Connected

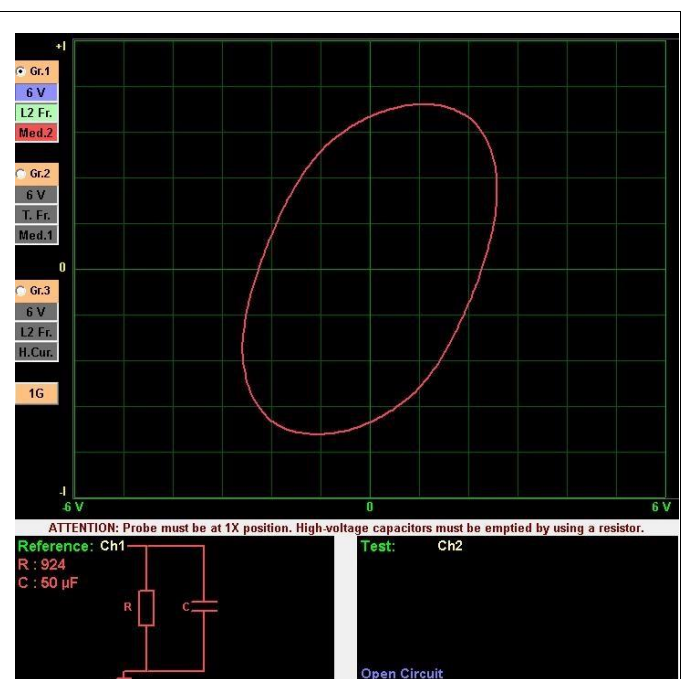


Figure 79: Capacitor - Resistor Parallel Connected

VI graph of the circuits comprised of Resistors and capacitors are composed of the VI graphs of the resistors and capacitors and the graphs of the RC circuits make an angle to the axes.

## Inductor VI Graph

The VI graph of the inductors is elliptical or circular like that of the capacitors. The width of the ellipse depends of the value of the component and the test stage of the device. Theoretically, the graph of a pure inductor is in form of an ellipse, but the ellipse may be distorted with the effect of the resistance of the inductor wires. The current stages cause changes in the shape of the ellipse. Changing the voltage stages has little effect on the ellipse.

The easiest way to troubleshoot the inductors is by comparing the VI graphs of the suspect and intact inductors.

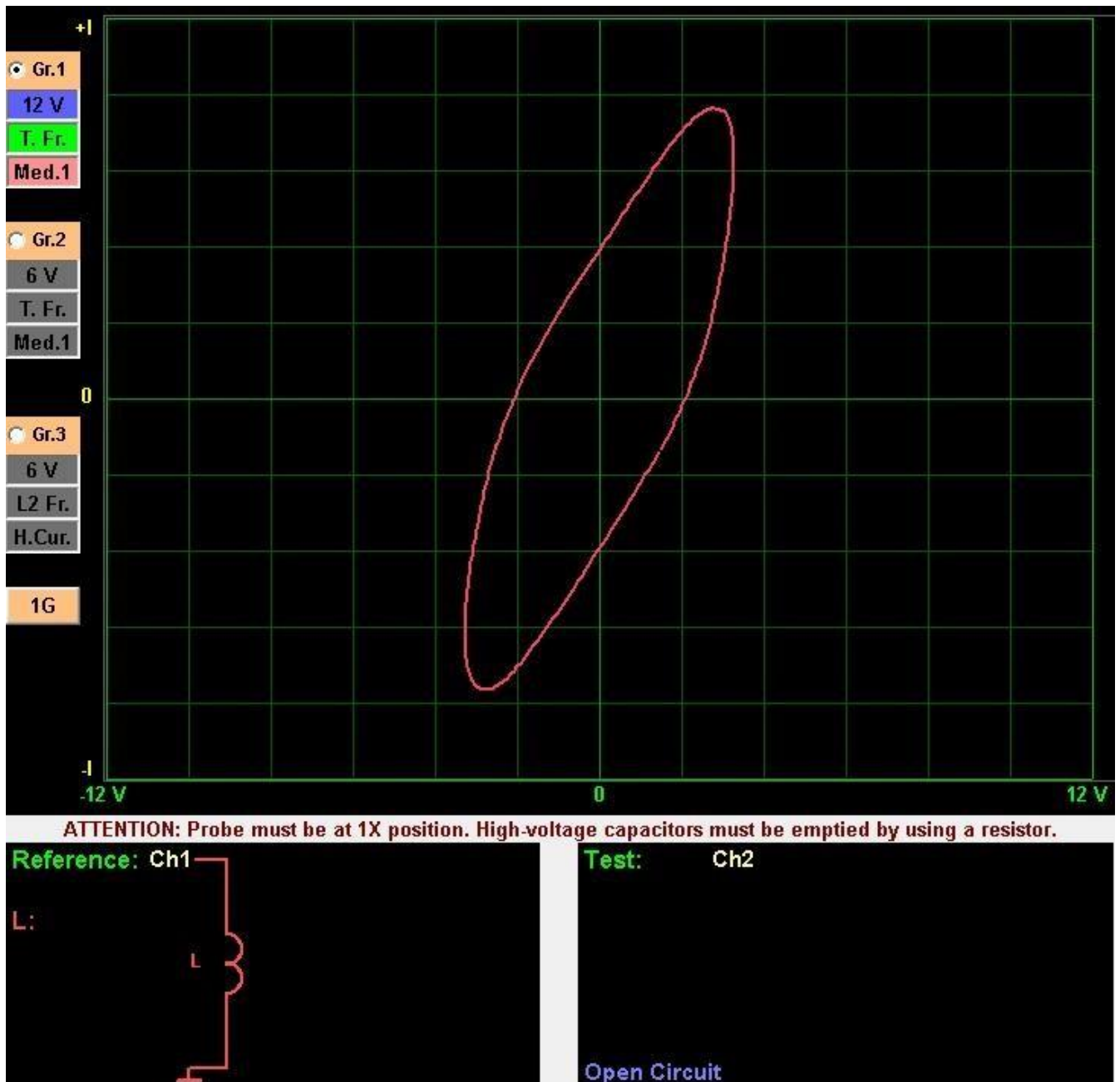
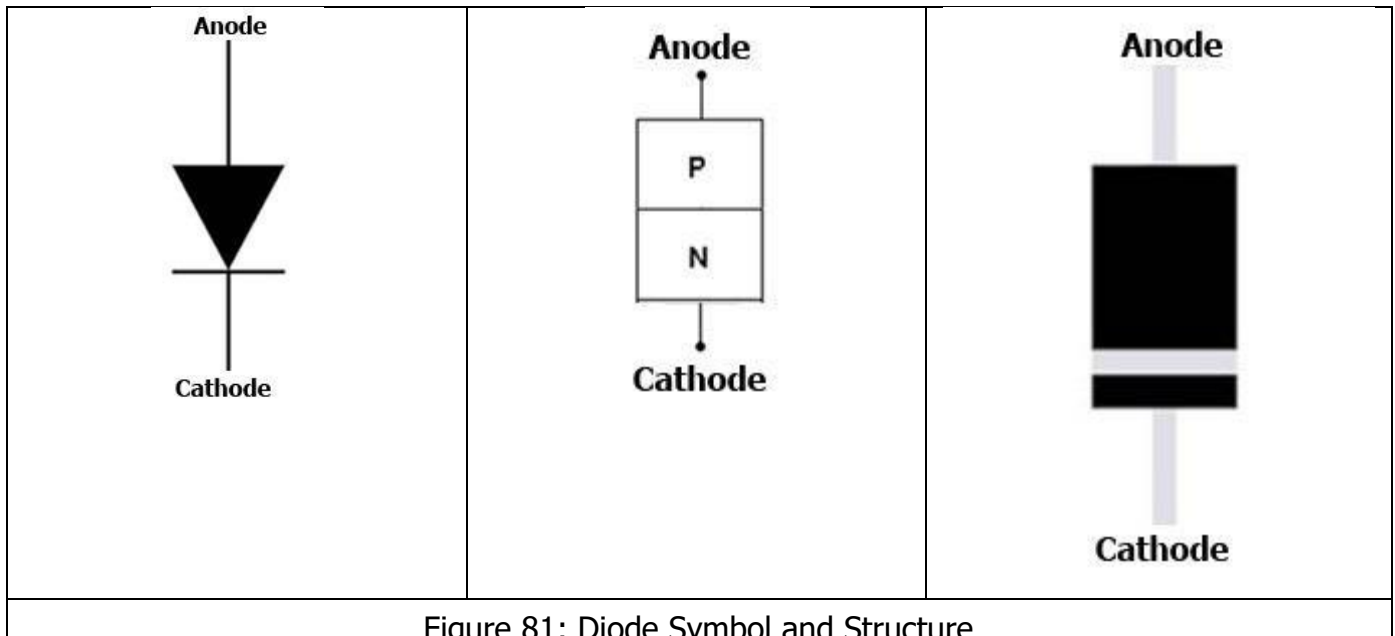


Figure 80: Inductor VI Graph

## SEMI CONDUCTORS

### Diode VI Graph

The Diodes are the building stones of semiconductor electronic circuit components. All transistors, logical gates, and integrated circuits are manufactured by combining the diodes. The diode is manufactured by joining N and P type materials. The P pole of diode is called the "Anode" and the N pole is called "Cathode". In general, the diode is an electronic circuit component which conducts the current in one direction only and blocks the flow in the opposite direction.



The diode starts conducting after the voltage applied exceeds a certain value. The reason for this is the voltage barrier that is formed at the surface of the junction of the materials used for making the diode. This voltage value is called the "threshold" voltage.

The Threshold voltage for the Germanium diodes is around 0,2 V - 0,3 V, and around 0.6 V - 0.7 V for the silicone diodes. The Threshold voltage may vary slightly according to the operating temperature of the diode.

If the voltage applied to the Diode is less than the threshold voltage, the diode does not conduct and the graph resembles an open circuit. This will start conducting and allow current flow only when the applied voltage exceeds the threshold value. The point of current conduction is called the "junction" where a horizontally and vertically straight graph is generated.



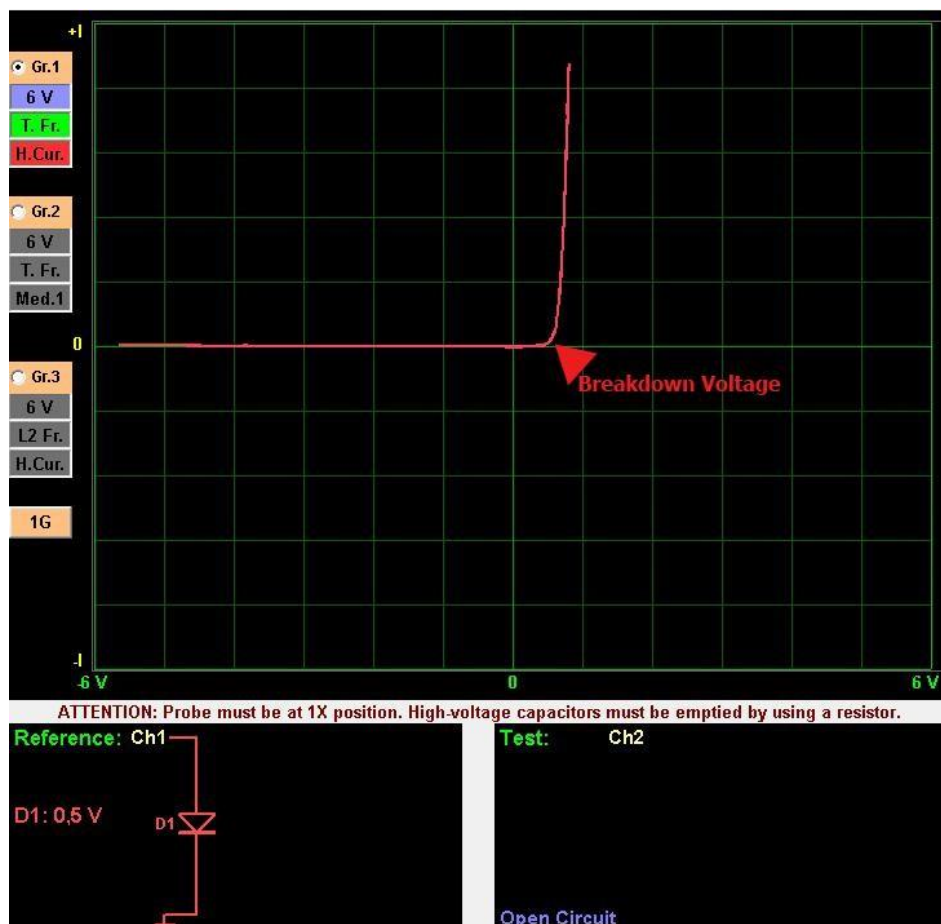


Figure 82: Diode VI Graph, Equivalent Circuit Diagram, Conduction Voltage Value

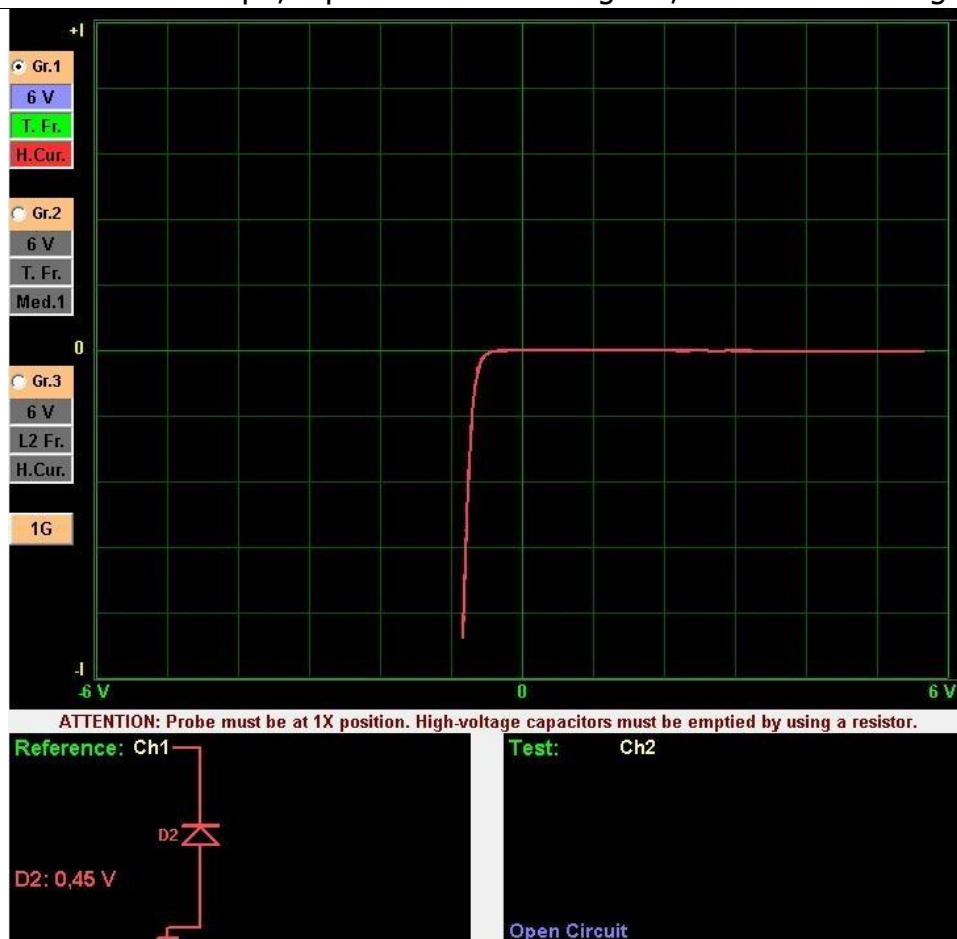


Figure 83: Diode Direction; Reverse Anode - Cathode

When a Semiconductor component fails, they generally act like resistors, but may also resemble open circuits. When the Diodes lose its semiconductor properties, the junction starts leaking current. (Figure 84 - Figure 85)

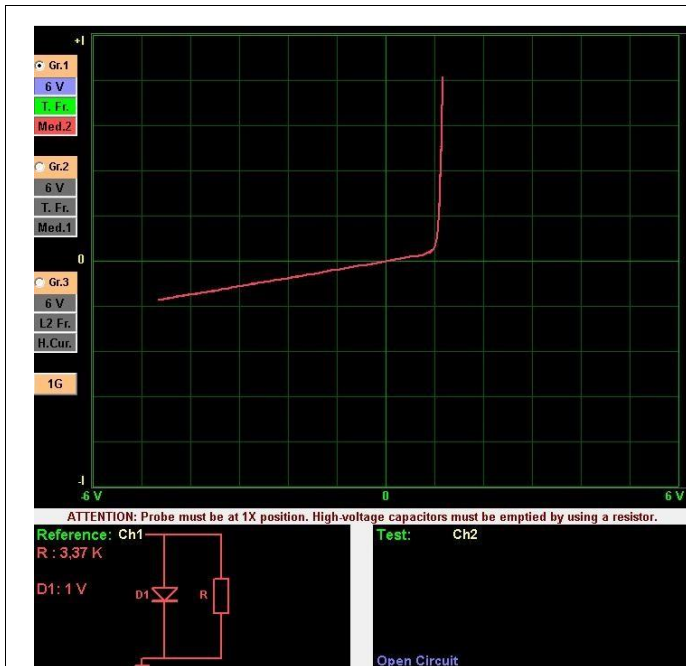


Figure 84: Defective Diode Graph

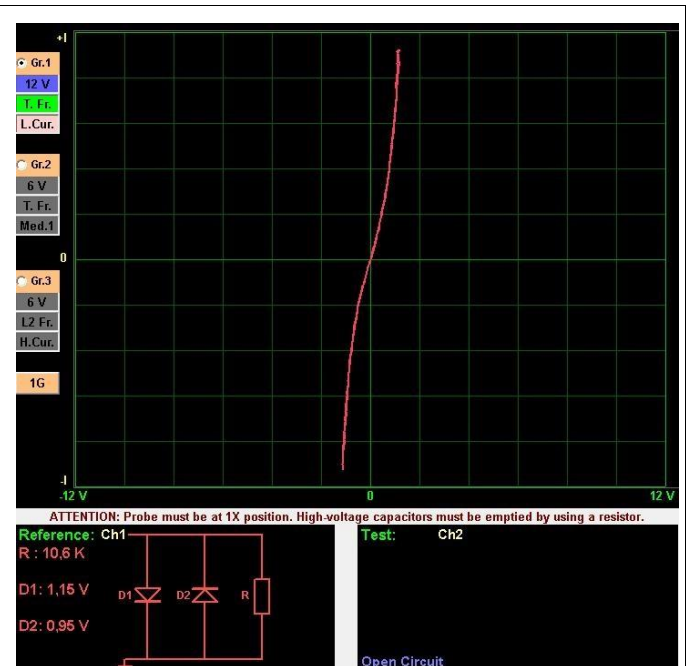


Figure 85: Defective Diode Graph

The new circuit graph generated by connecting the Electronic components in parallel or in series is a combination of the graphs of the components used in that circuit.

When a series resistor is connected to the diode, the diode makes an angle horizontal from the junction point. (Figure 86 and Figure 87)

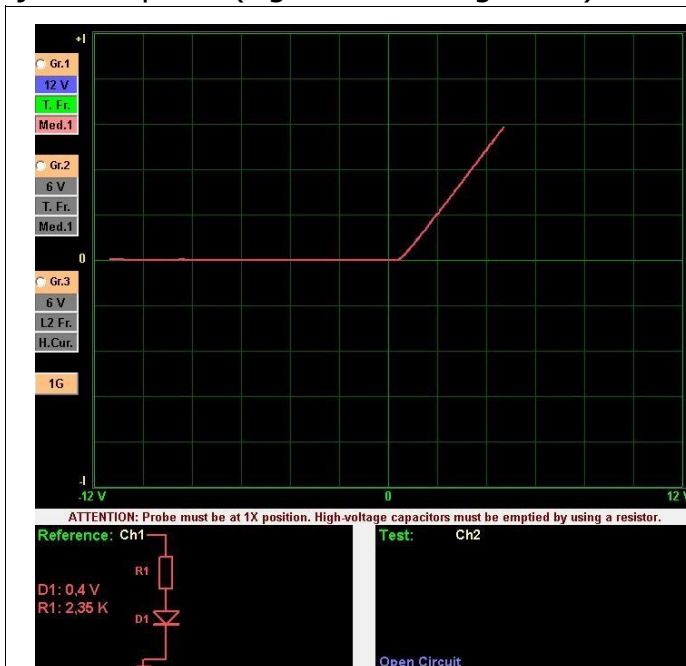


Figure 86: Diode - Resistor Series Connected

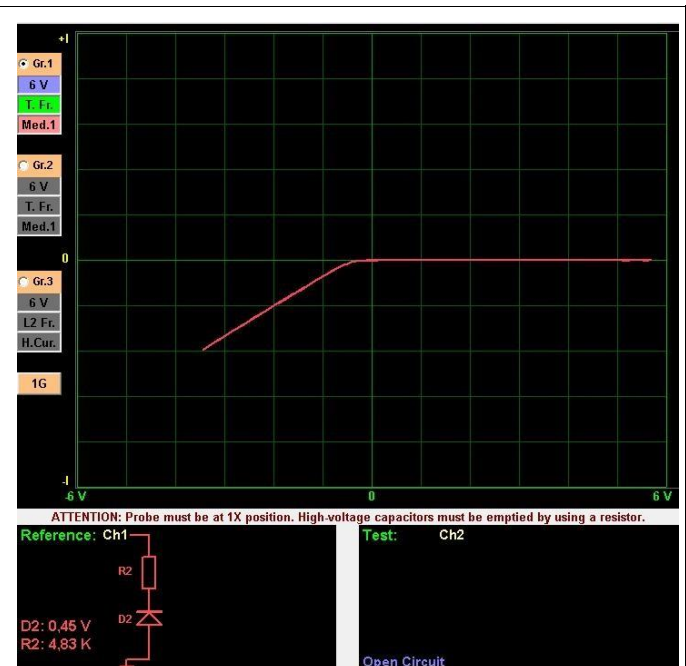
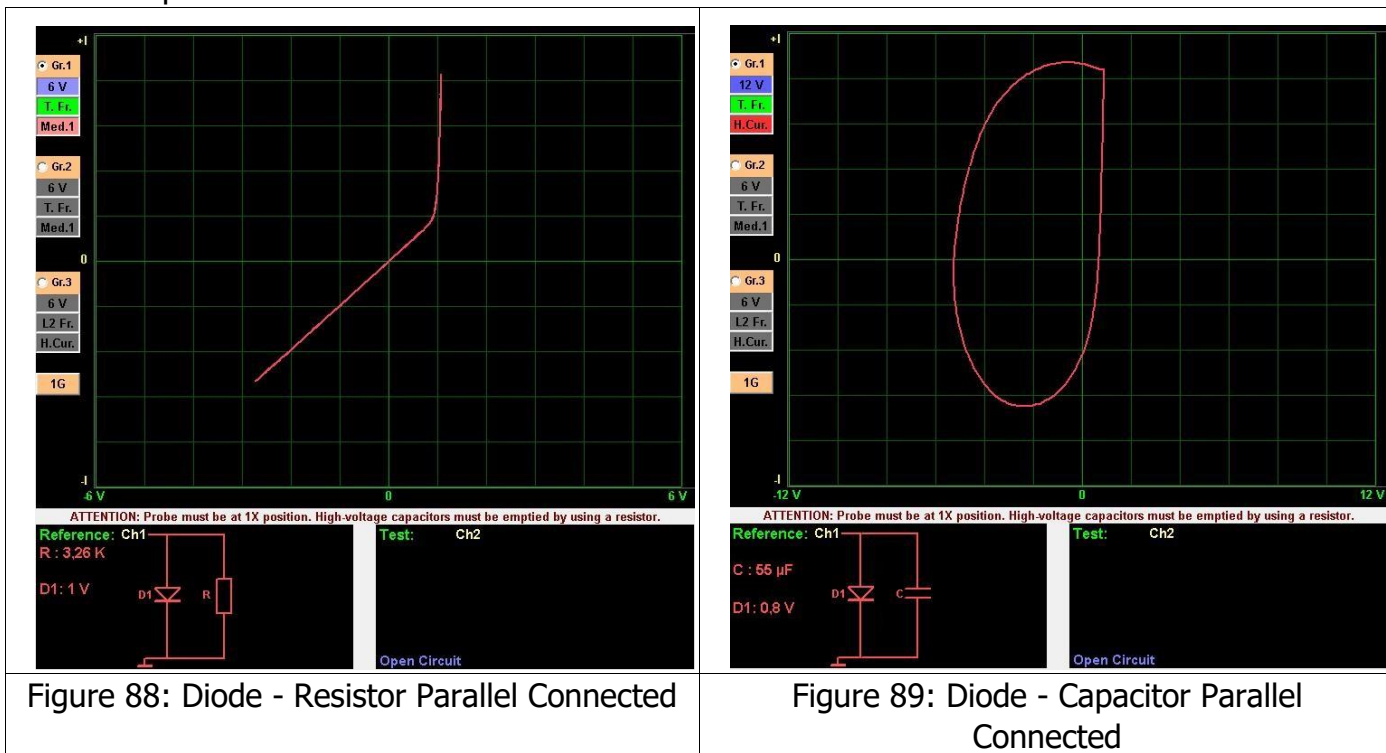


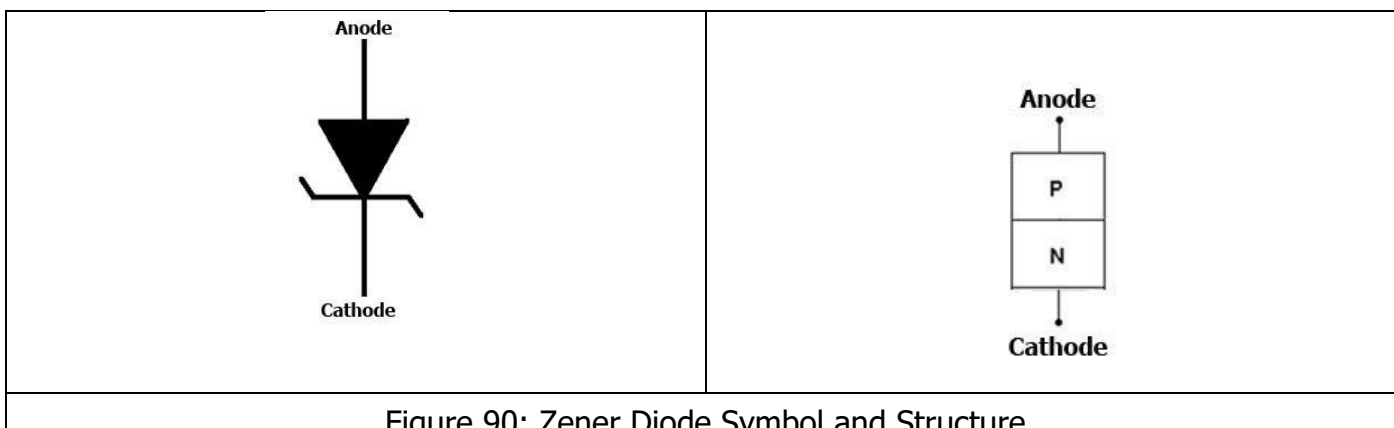
Figure 87: Reverse Diode - Resistor Series Connected

For example, a parallel resistor is connected to the diode as seen in Figure 88 and a capacitor is connected in parallel as shown in Figure 89. We can observe the effects of a resistor or capacitor or resistor connected to the diode in parallel on the vertical axis as shown in the graphs. When a series resistor is connected to the diode, the diode makes an angle horizontal from the junction point. This graph is quite common for electronic circuits. We can change the voltage stages of the TESTIT FD20 to stop the diode from conducting and concentrate on the VI graphs of the other components.



## Zener Diode VI Graph

The Zener diode is a special type of diode in general which has a silicone structure comprised of P and N type semi-conductor materials. The main purpose of the diode is keeping the voltage applied to its poles stable. They do not conduct until the voltage exceeds a certain value. This voltage is called the “Zener Breakdown” voltage.



When connected to the circuit with the correct polarity it operates like a normal diode. In case of reverse polarity, it operates on the Zener diode principle and provides electrical protection to the

component it is connected. Therefore, Zener diodes are often connected in reverse polarity for protection purposes.

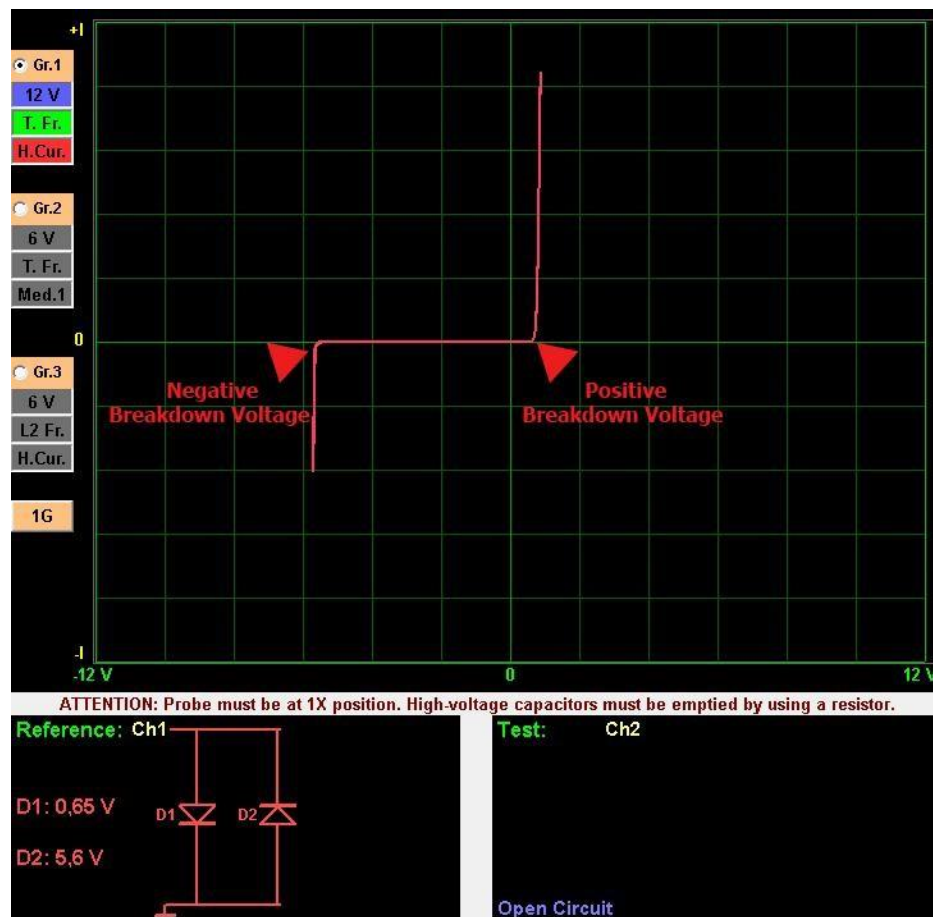


Figure 91: Zener Diode VI Graph, Equivalent Circuit Diagram and Conduction Voltage Values

There are two breakdown points in the Zener graph in positive and negative directions. The Zener graph is frequently observed while testing integrated circuits (ICs).

## TRANSISTOR – TRIAC – THYRISTOR – FET – IGBT – OPTO-COUPLER VI GRAPH

### Transistor VI Graph

Transistors are composed of three semiconductor elements arranged in NPN or PNP configuration. In the NPN type transistor structure, a P type semiconductor base material is placed between two N type semiconductor materials in a thin layer. The structure of the PNP type transistor is similar to the NPN type. In the PNP type transistor structure, an N type semiconductor base material is placed between two P type semiconductor materials. The only difference is a N type semiconductor base material is placed between two P type semiconductor materials in a thin layer.

The poles of the transistors are composed of three circuit elements called the Emitter (E), Base (B) and Collector (C).

In the equivalent circuit of a Transistor, the Collector – Base connection is like a diode graph and the Base - Emitter graph is like a Zener diode. We can check if the transistor is conducting by using the TESTIT FD20.

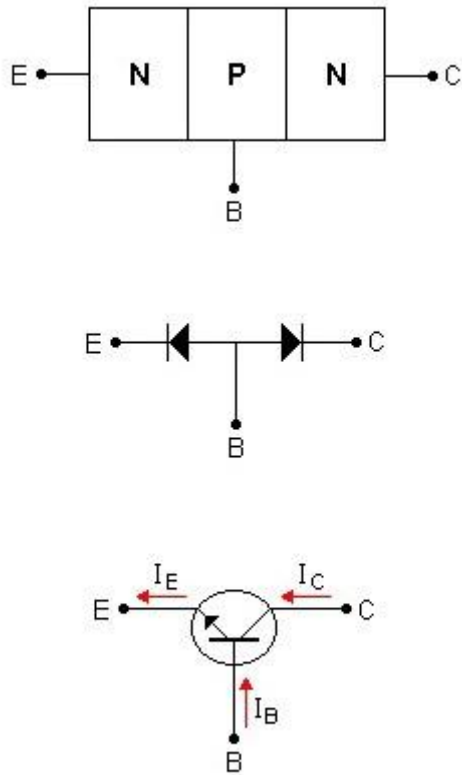


Figure 92: NPN Transistor Symbol and Structure

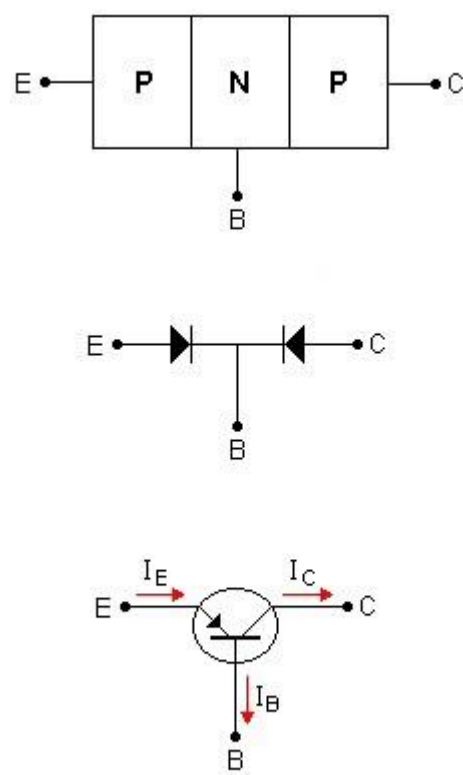


Figure 93: PNP Transistor Symbol and Structure

If the **T.T.T FET IGTB** option is clicked in the TESTIT FD20 test characteristics menu, the software analyzes the transistor type as N or P. To do that, the Emitter is connected to the chassis. One of the probes is connected to the Base to trigger the transistor and the other to the Collector to detect the conduction. When the Base pole is triggered, the resistance value between the Collector and Emitter drops and allows current flow. The amount of current flowing through the Collector and Emitter depends on the current applied to the base.

For example, the Emitter is connected to the chassis. The Channel 2 (or Channel 1) probe is touched to the Collector and the other probe is touched to the Base of the transistor, where upon the current will start flowing through the collector and a change will be observed in the Collector VI graph of the transistor that was just triggered. If the **T.T.T FET IGTB** option is selected (clicked), the type of the transistor is analyzed. Figure 104 illustrates the VI graph of an NPN type transistor and Figure 121 illustrates the VI graph of a PNP type transistor. Absence of leakage at the cut-off region (fully horizontal) corroborates the intact status of the device.



## NPN Type Transistor VI Graph Samples

### BC850C (SMD) NPN Transistor

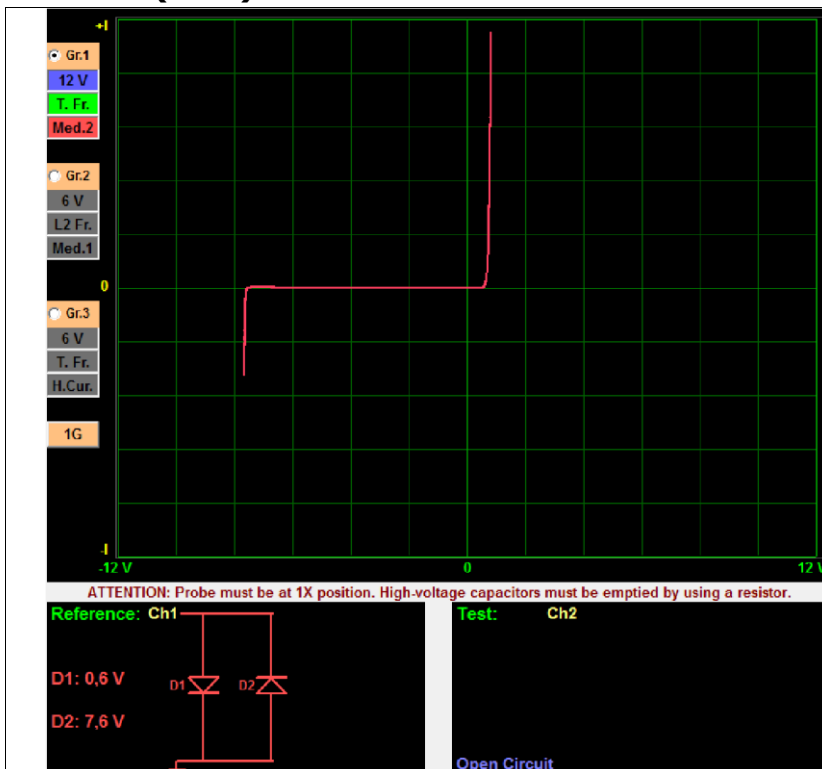


Figure 94: Base (+) Emitter (-) VI Graph

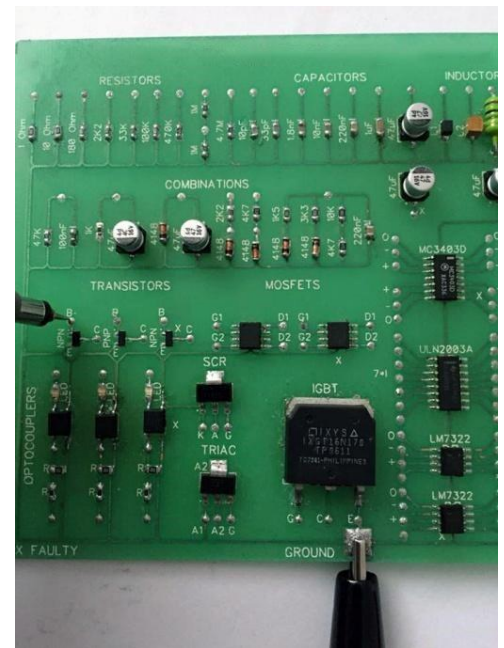


Figure 95: Channel1 Probe Used for Base - Emitter Measurement

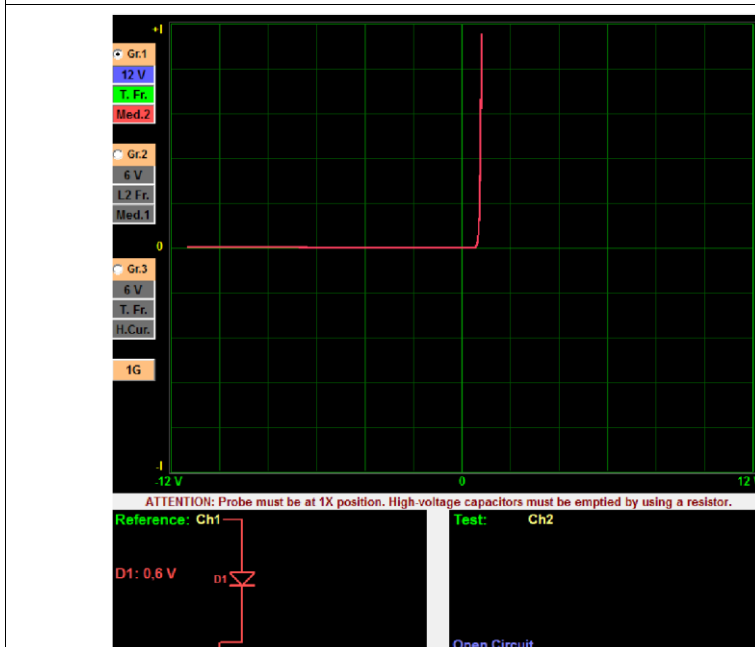


Figure 96: Base (+) Collector (-) VI Graph

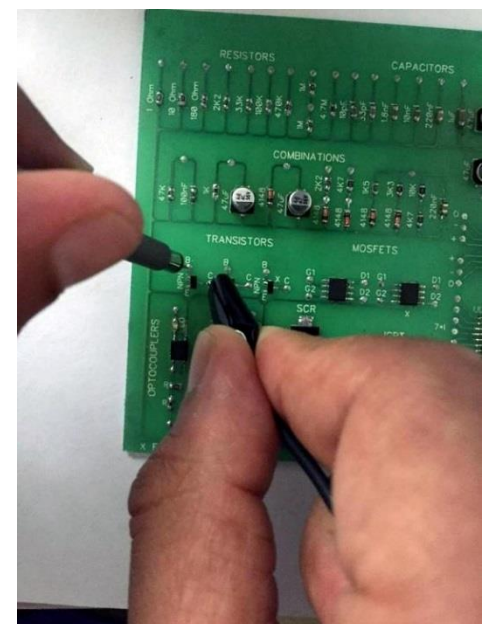


Figure 97: Channel1 Probe Used for Base - Collector Measurement

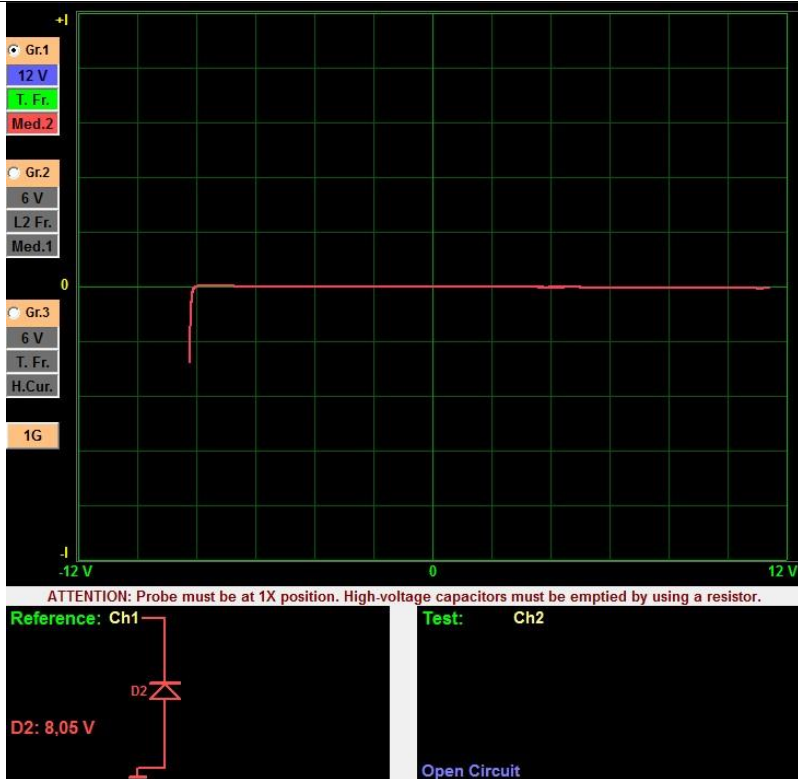


Figure 98: Collector (+) Emitter (-) VI Graph

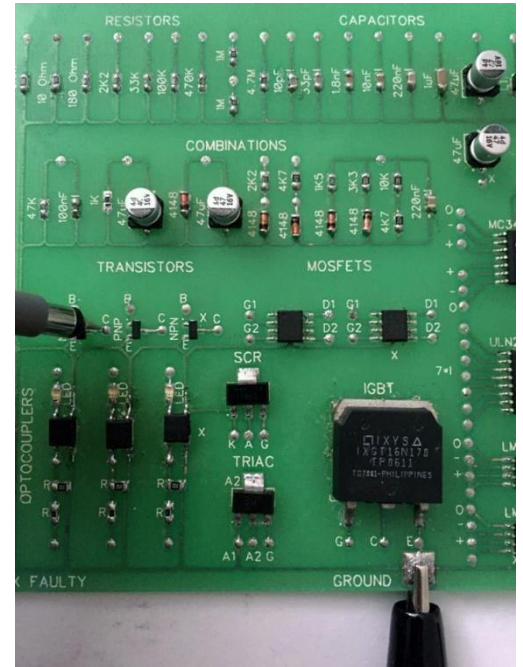


Figure 99: Channel1 Probe Used for Collector - Emitter Measurement

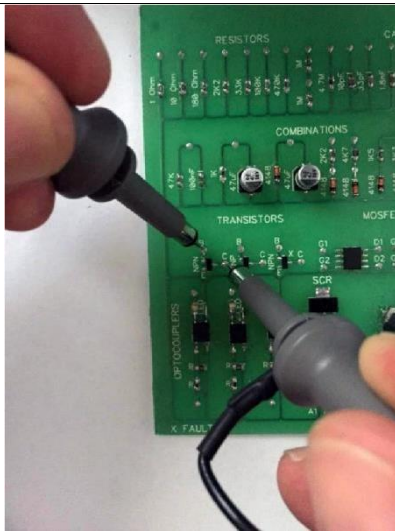


Figure 100: Channel1 (+), Channel2 (+), COM (-)  
Transistor Test

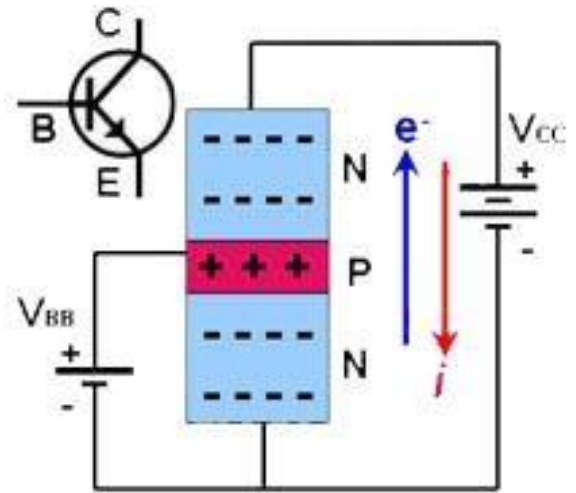


Figure 101: Transistor Conduction

In the NPN type transistors, while the positive side of the  $V_{bb}$  source charges the base

positively, the negative side of the  $V_{cc}$  side pushes the electrons at the emitter upwards as seen in Figure 101. The compressed electrons are pulled by the base. That is, the electrons at the emitted conduction band overcome the E-B voltage barrier and enter the base region, but since the base region is very narrow, 98% of the electrons coming from the emitter side pass to the collector side while approximately 2% remains in the base region. The plus side of the  $V_{cc}$  source pulls the electrons to the collector region, which makes the electron flow continuous. As long as the base current is applied, the electron flow from the emitter to the collectors goes on. In the NPN type transistors the electrons move upwards while the holes move downwards,

hence why the plus signal applied at the base is said to cause an electron flow from the collector to the emitter. The emitter current is equal to the sum of the base and collector currents.

We can test a transistor with the TESTIT FD20 as shown in Figure 101. As shown in Figure 100, one of the channels may be connected to the Vcc supply and the other to the Vbb supply. The COM Probe is connected to the chassis. When you touch the Channel1 to the Collector, you will either see a graph as shown in Figure 98 or an open circuit. When the base is triggered (touched) with Channel2, the current flow between the collector and emitter will be shown on the graph (Figure 102).

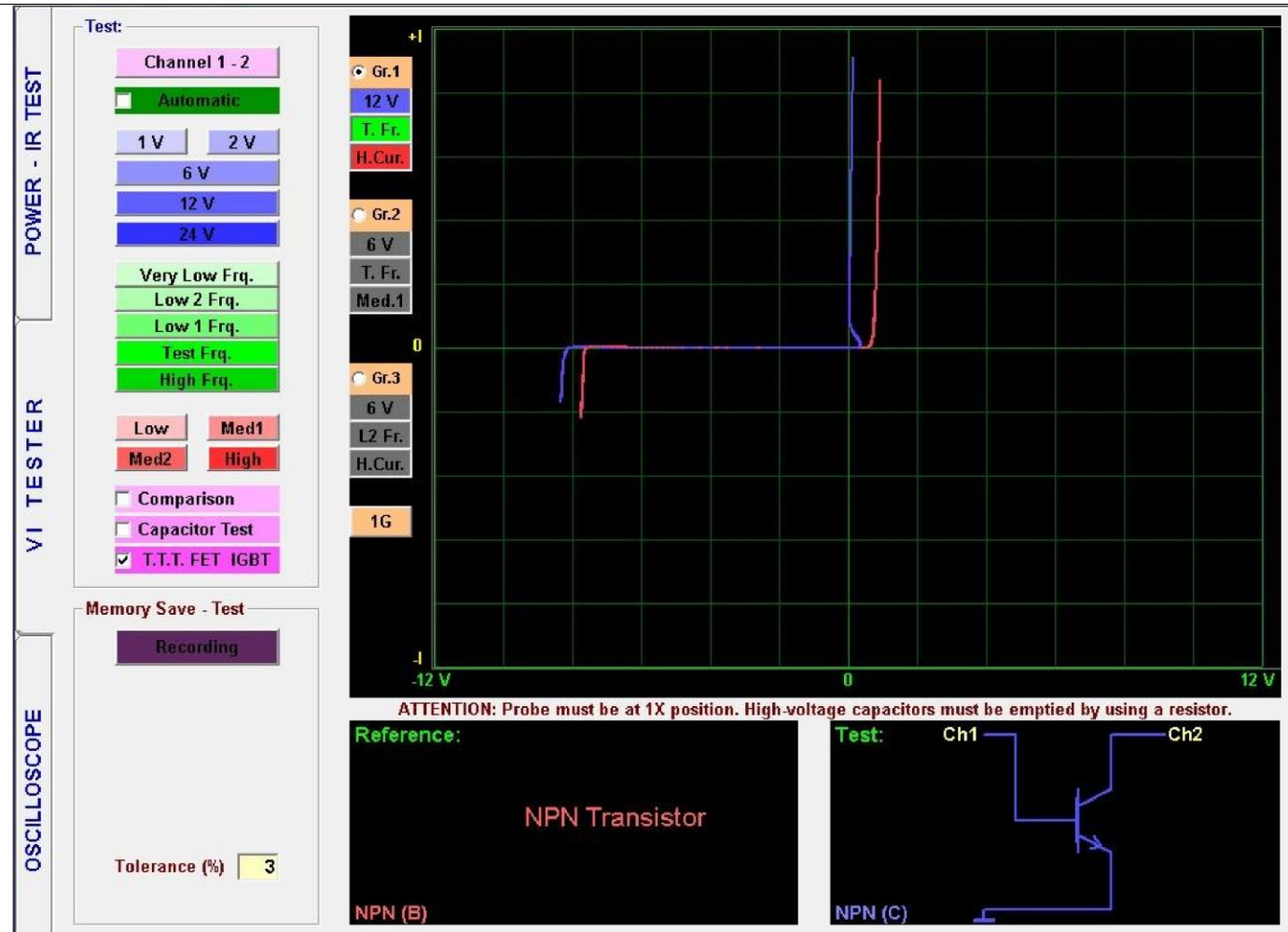


Figure 102: NPN Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Base, Channel2 Collector)

## C546B NPN Transistor

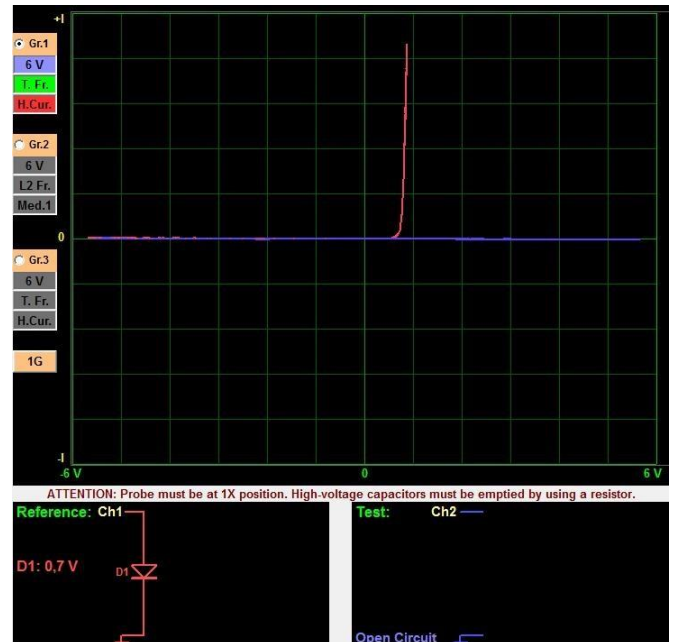
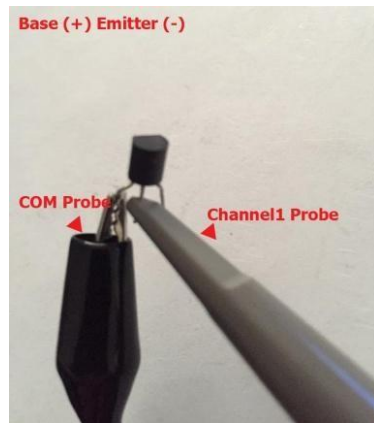
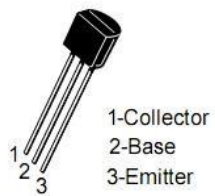


Figure 103: Channel1 Probe used for Base - Emitter Measurement

Figure 104: Base (+) Emitter (-) VI Graph

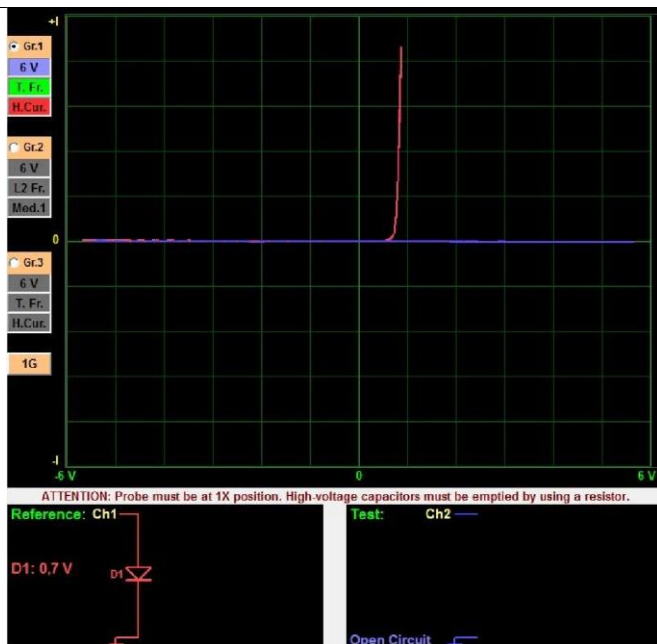


Figure 105: Base (+) Collector (-) VI Graph

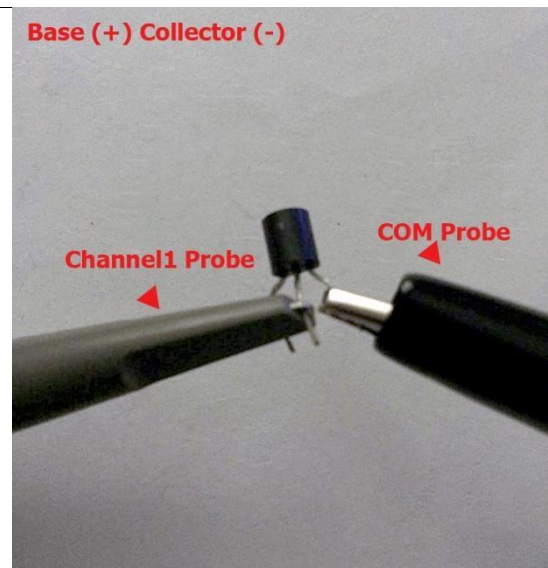


Figure 106: Channel1 Probe Used for Base Collector Measurement



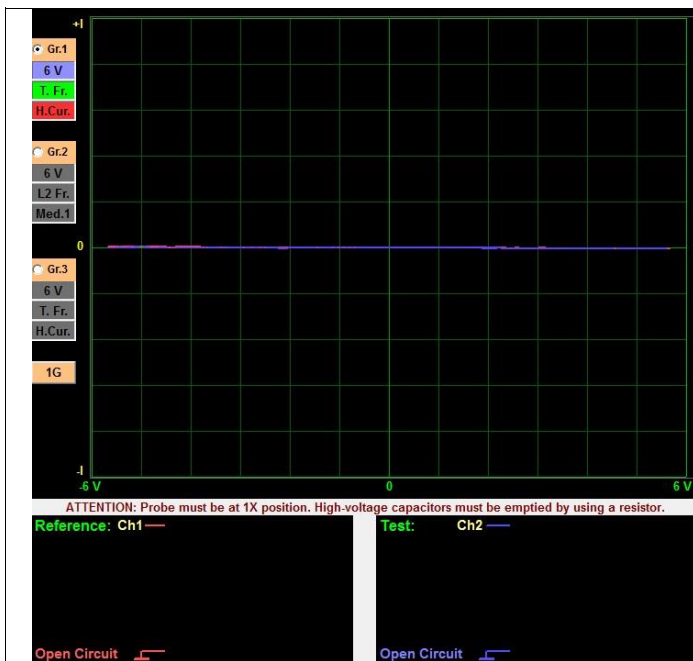


Figure 107: Collector (+) Emitter (-) VI Graph

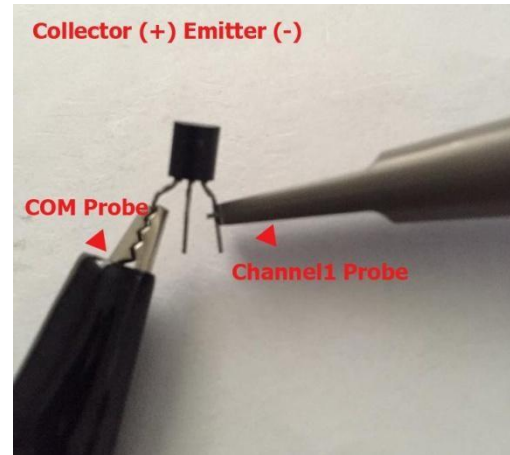


Figure 108: Channel1 Probe Used for Collector - Emitter Measurement

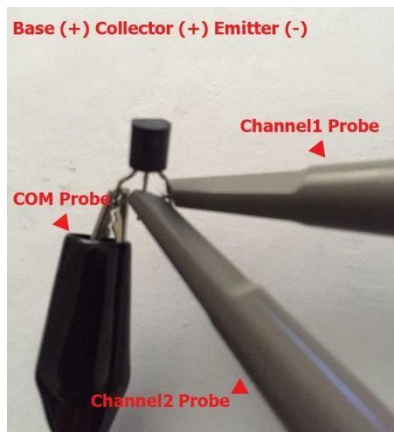


Figure 109: Channel1 (+), Channel2 (+), COM (-) Transistor Test

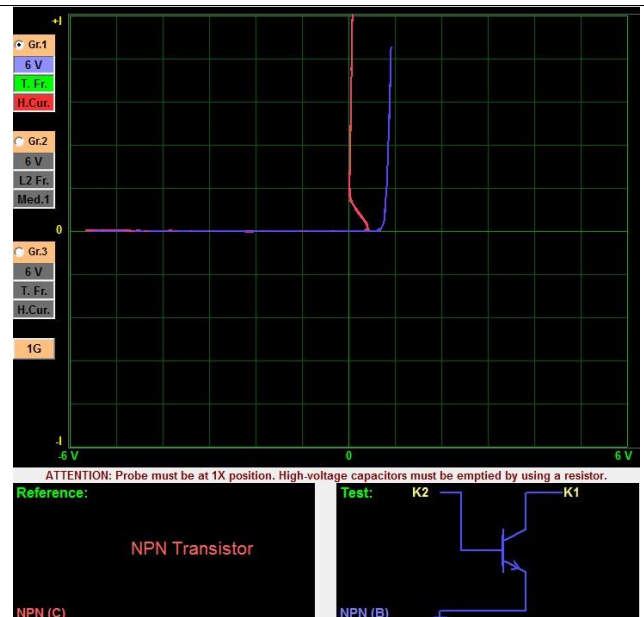


Figure 110: NPN Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Collector, Channel2 Base)



## 2N3055 NPN Transistor

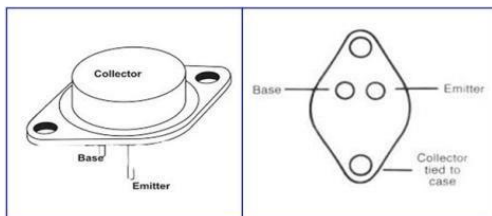


Figure 111: Channel1 (+), Channel2 (+), COM (-) Transistor Test

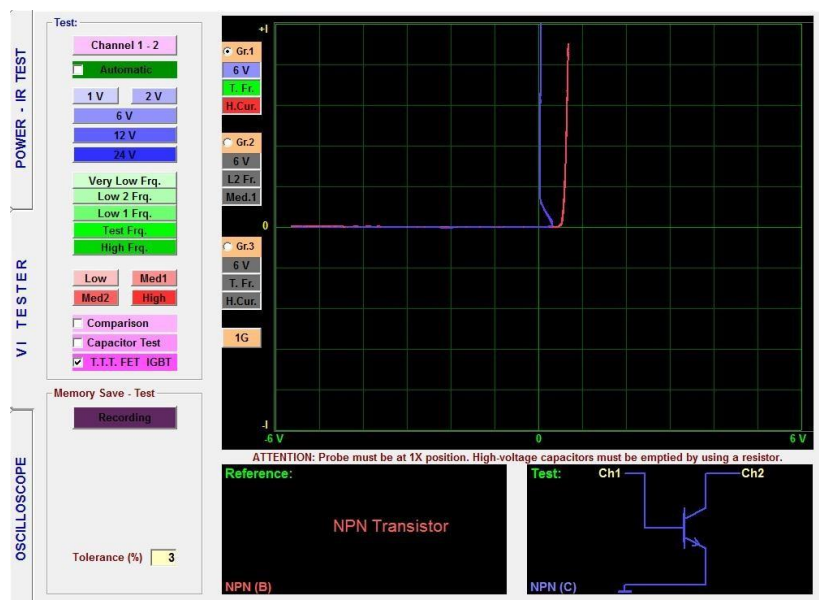


Figure 112: NPN Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Base, Channel2 Collector)

## PNP Type Transistor VI Graph Samples

### BC857C PNP Transistor

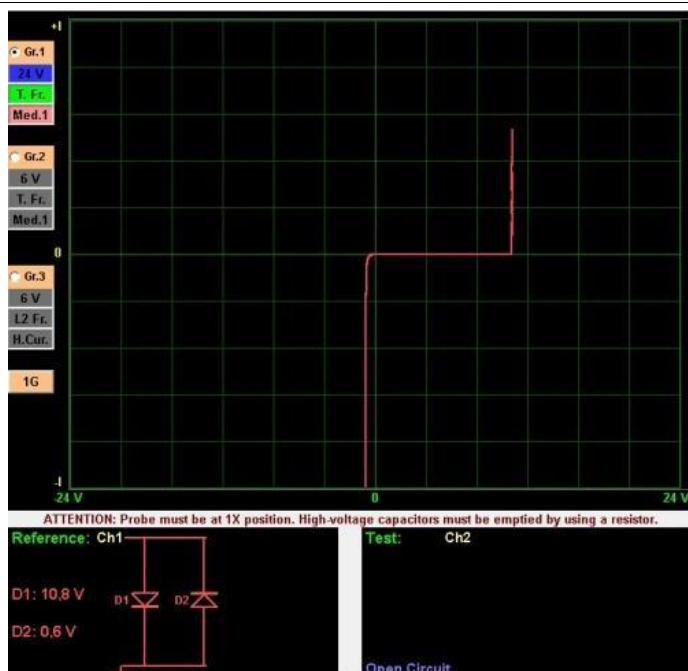


Figure 113: Base (+) Emitter (-) VI Graph

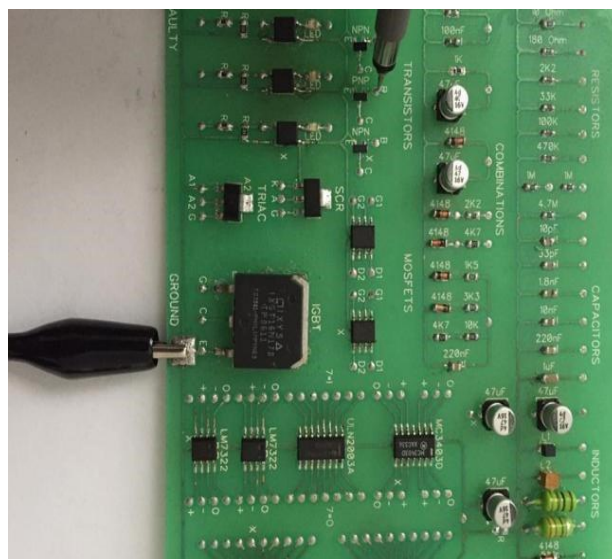


Figure 114: Channel1 Probe Used for Base - Emitter Measurement

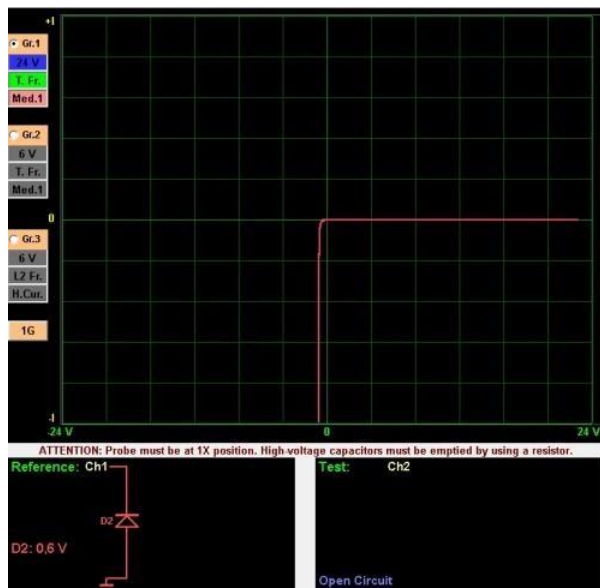


Figure 115: Base (+) Collector (-) VI Graph

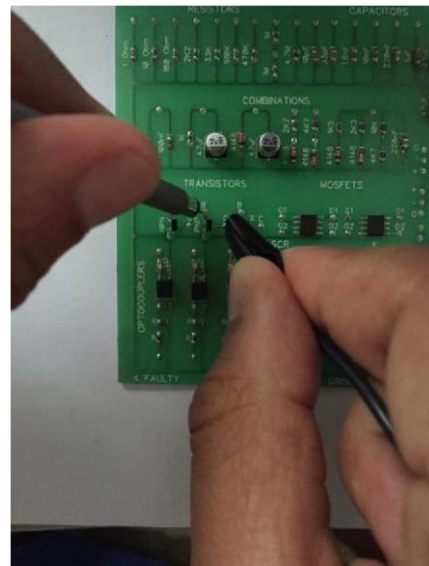


Figure 116: Channel1 Probe Used for Base - Collector Measurement

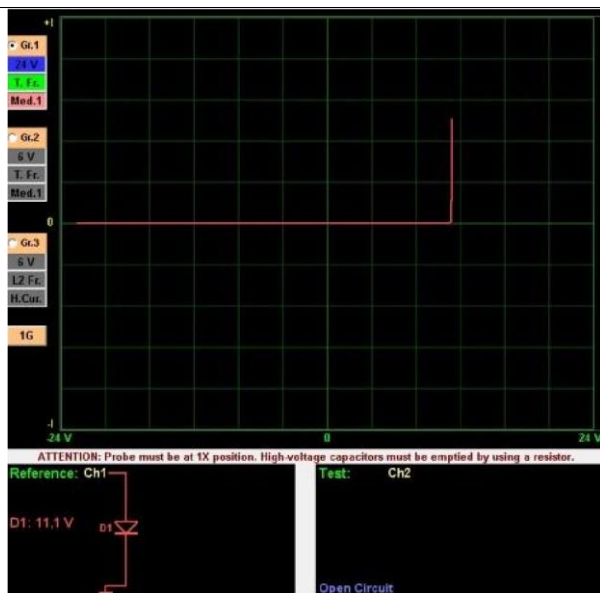


Figure 117: Collector (+) Emitter (-) VI Graph

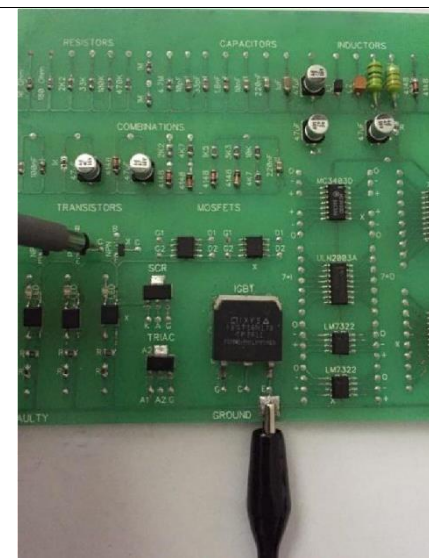


Figure 118: Channel1 Probe Used for Collector - Emitter Measurement

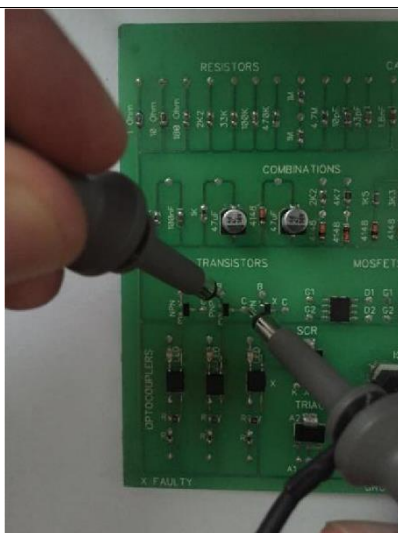


Figure 119: Channel1 (+), Channel2 (+), COM (-) Transistor Test

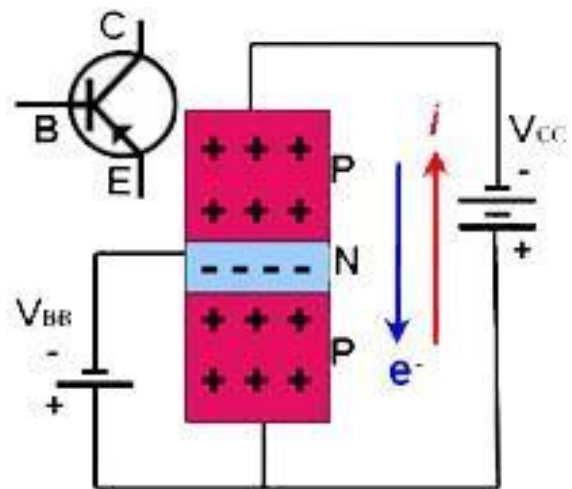


Figure 120: Transistor Conduction

In the PNP type transistors, while the minus side of the  $V_{bb}$  source pulls the base side towards

negative, the plus side of the Vcc source pushes the plus charged holes at the emitter region upwards as shown in Figure 120. The plus charges thus compressed are pulled towards the base and migrate to the collector region from here. Since the minus side of the Vcc source attracts the holes in the collector region, the hole movement gains continuity. As long as the VBB current is present, this movement from the emitter towards the collector also continues. In the PNP type transistors, the electrons move downwards and holes move upwards and therefore, the minus signal applied to base is said to cause a current flow from the emitter to the collector.

We can test a transistor with the TESTIT FD20 as shown in Figure 120. One of the channels may be connected to the Vcc supply and the other to the Vbb supply (Figure 119). The COM Probe is connected to the chassis. When you touch the Channel1 to the Collector, you will either see a graph as shown in Figure 117 or an open circuit. When the base is triggered (touched) with Channel2, the current flow between the collector and emitter will be shown on the graph (Figure 123).

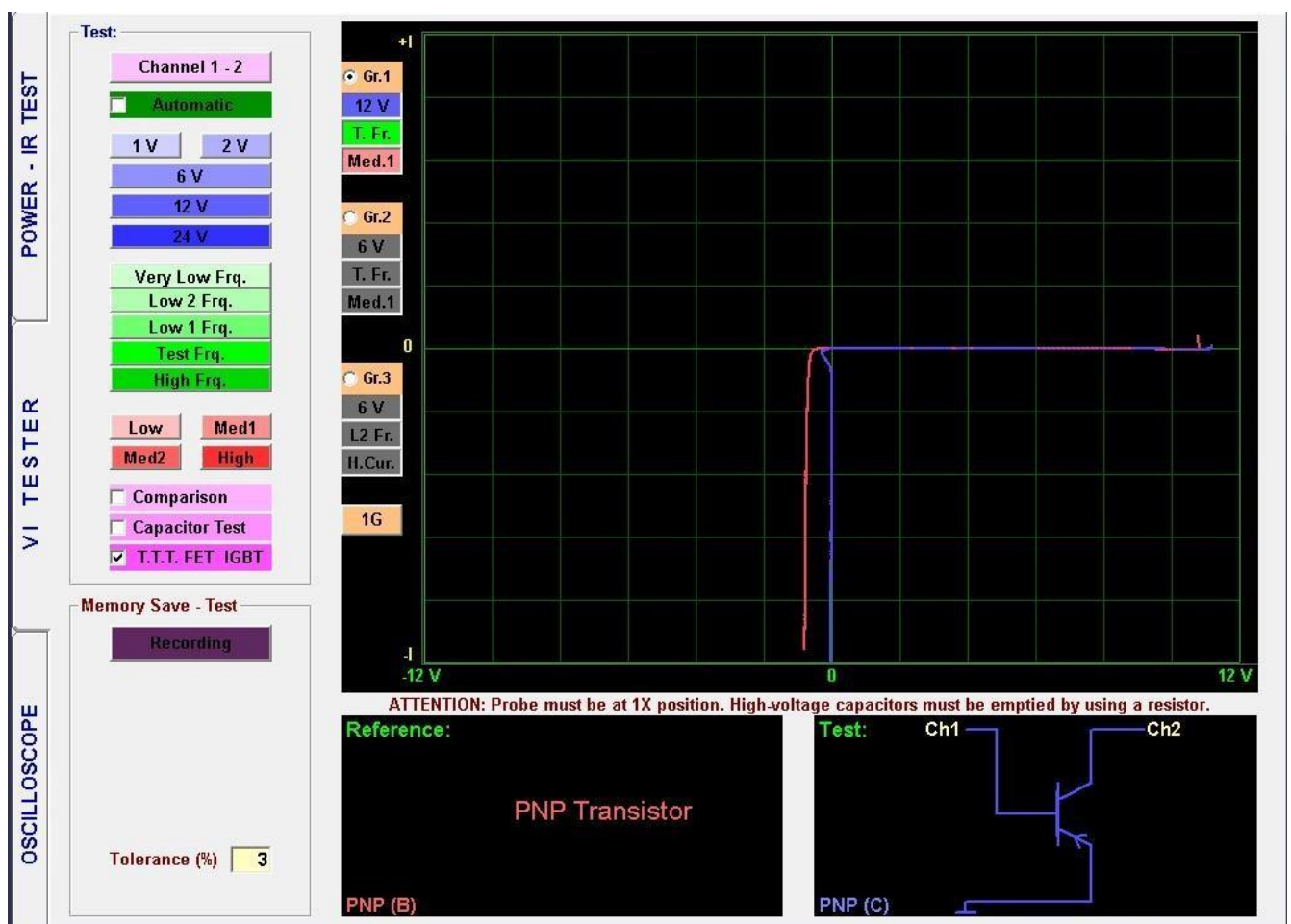


Figure 121: PNP Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Base, Channel2 Collector)



## TIP42C PNP Transistor

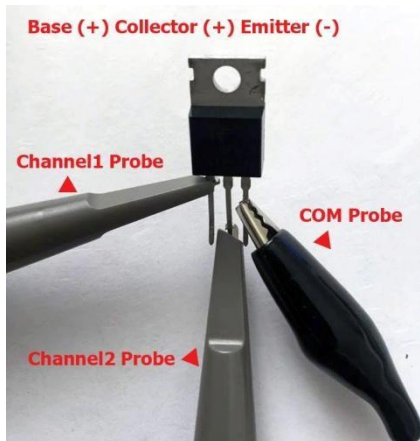
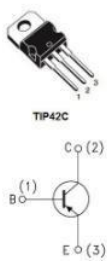


Figure 122: Channel1 (+), Channel2 (+), COM (-) Transistor Test

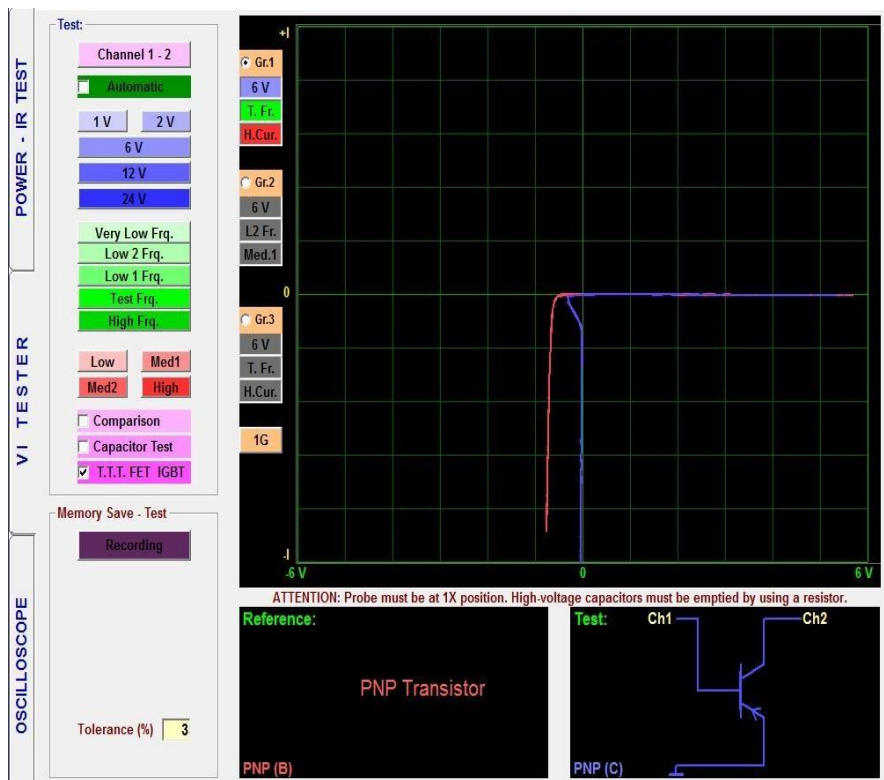


Figure 123: PNP Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Base, Channel2 Collector)

## C556B PNP Transistor

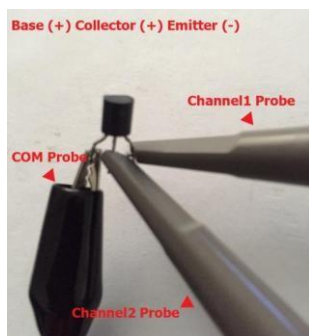
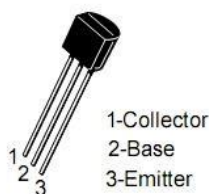


Figure 124: Channel1 (+), Channel2 (+), COM (-) Transistor Test

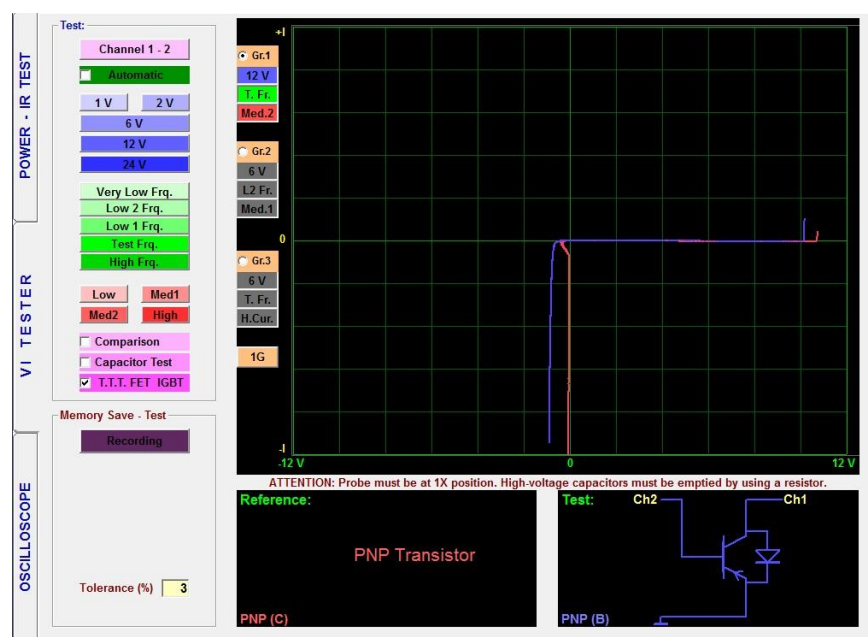


Figure 125: PNP Transistor VI Graph, Equivalent Circuit Diagram (Channel1 Collector, Channel2 Base)

## **MOSFET – FET VI Graph**

The Mosfet is a field effect transistor which is used in analog and digital circuits frequently. The Mosfets are also three-pin devices like transistors. Those pins are the G (gate, normal transistor's base pin), S (source) and D (drain, normally the transistor's collector).

**N Channel JFET Transistor:** The N channel JFET transistor is a combination of two P type and one N type material.

**P Channel JFET Transistor:** The operating principle of the P channel JFET transistors is the same as the N channel JFETs. The only difference is the direction of polarization and the reverse location of the P and N materials.

The FETs consist of a channel that contains a semiconductor material and a region (Gate) made of a semiconductor material with opposite characteristics. The Gate diode shapes the diode with its connections at both ends of the channel (source and drain) and those diodes can be tested. Both probes can be used for testing the 3 pin active devices. One of the probes shows the triggering signal and the other shows the conduction state. If conduction starts, when the T.T.T FET IGTB feature is clicked in the test characteristics menu, the type of the FET – MOSFET as N type or P type FET is analyzed.



## IRF3205 Power Mosfet (N)

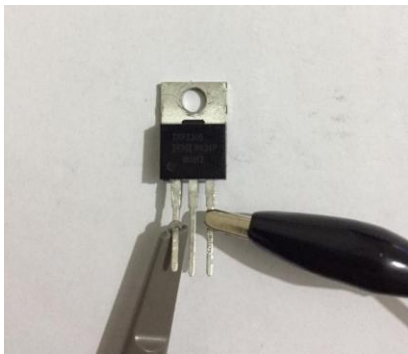
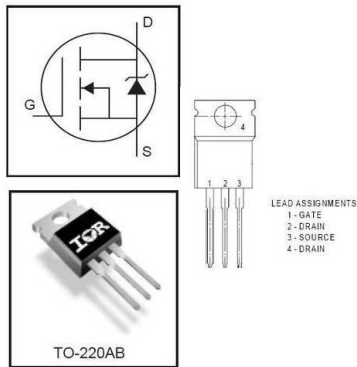


Figure 126: Channel1 Probe Used for Gate - Source Measurement

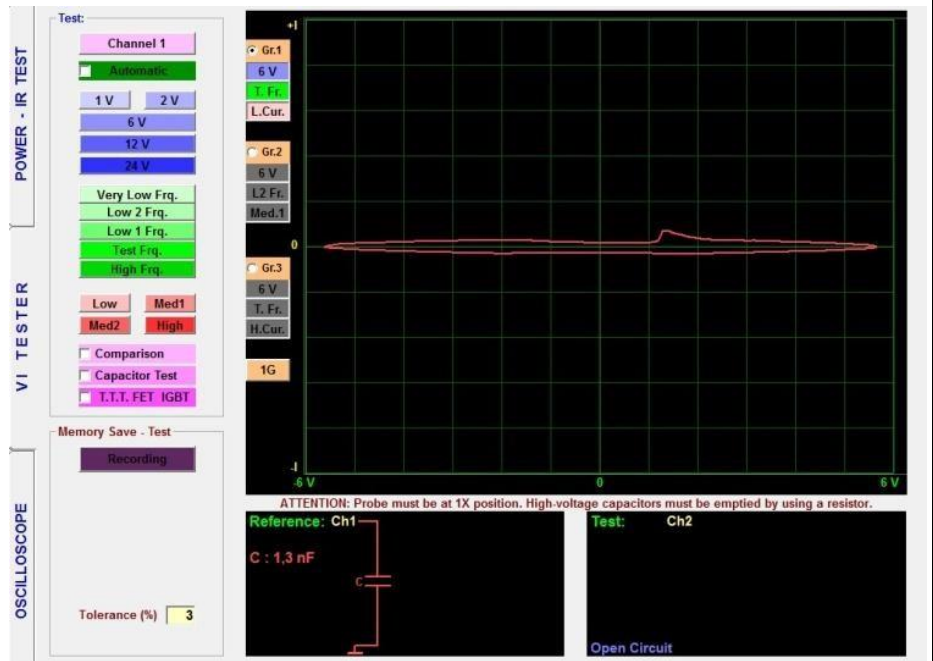


Figure 127: Gate (+) Source (-) VI Graph

In the Mosfets, the input impedance is high, and the internal capacitance between the electrodes is very low. Therefore, a capacitor effect is observed between the Gate and Emitter.

When the gate pin is touched with the probe, the capacitor starts charging and when we remove the probe, the capacitor starts discharging. Depending on the charge and discharge state, that is the fullness condition, of the capacitor the following graphs may be observed during the Drain - Source test.

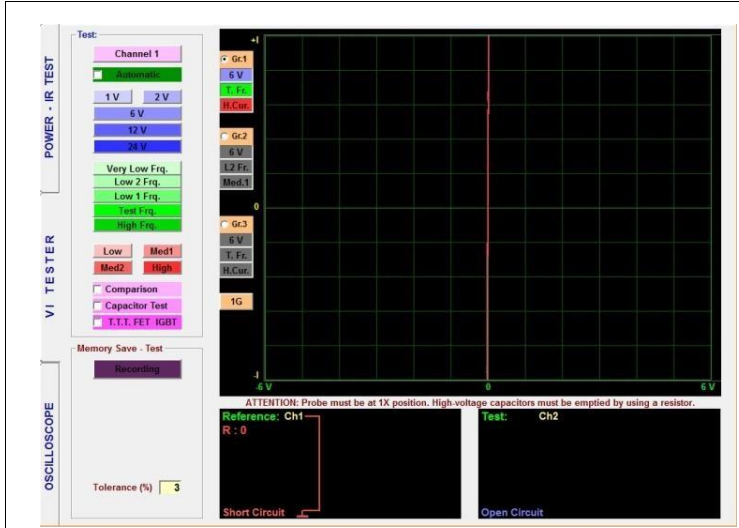


Figure 128: Drain (+) Source (-) VI Graph

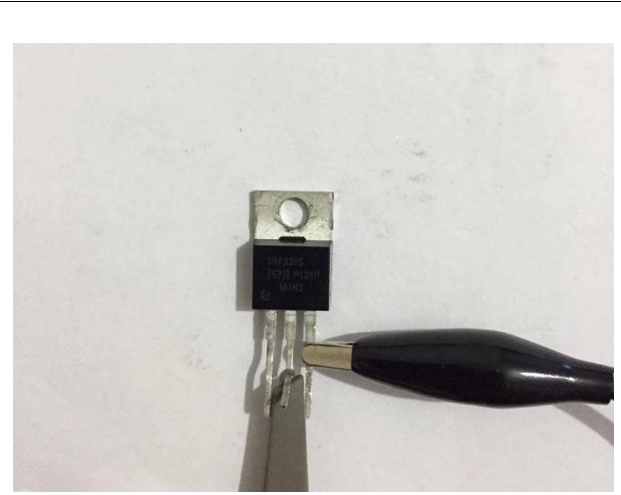


Figure 129: Channel1 Probe Used for Drain - Source Measurement

The VI graph between Drain (+) and Source (-) is shown in Figure 128 according to the fullness (charge) rate of the capacitor between the Gate and Emitter.

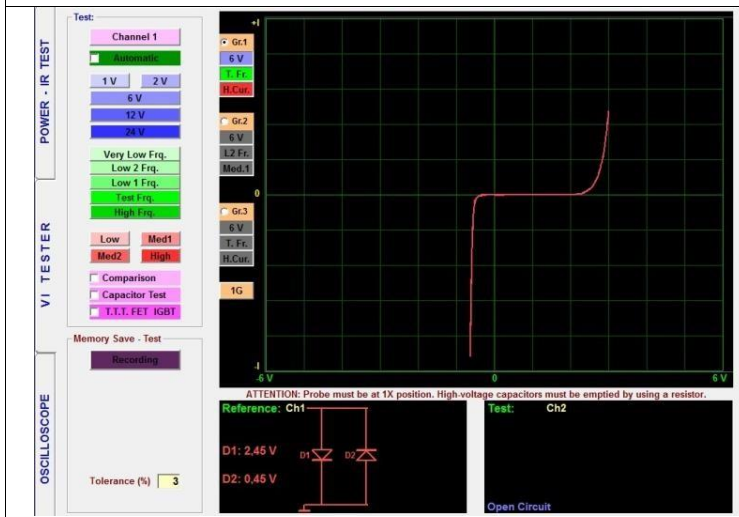


Figure 130: Drain (+) Source (-) VI Graph

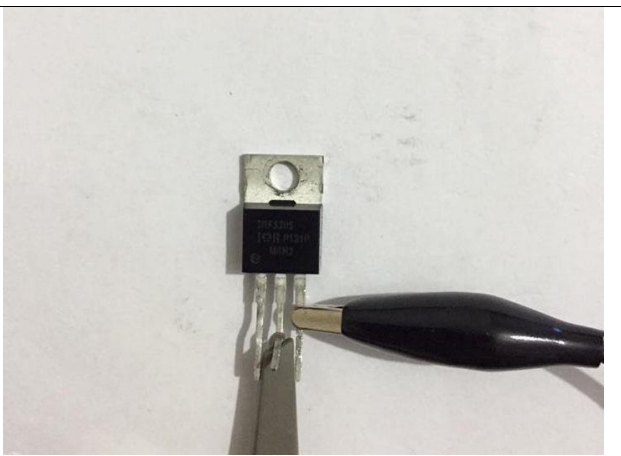


Figure 131: Channel1 Probe Used for Drain - Source Measurement

The VI graph between Drain (+) and Source (-) is shown in Figure 130 according to the fullness (charge) rate of the capacitor between the Gate and Emitter.

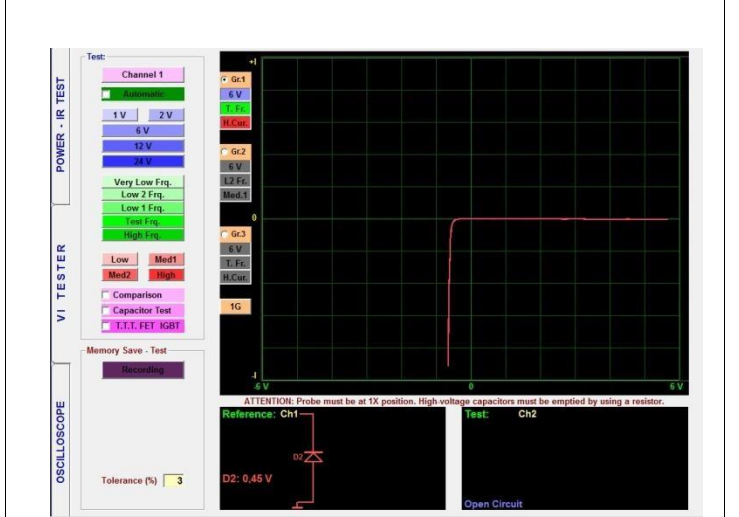


Figure 132: Drain (+) Source (-) VI Graph



Figure 133: Channel1 Probe Used for Drain - Source Measurement

The VI graph between Drain (+) and Source (-) is shown in Figure 132 according to the fullness (discharge) rate of the capacitor between the Gate and Emitter.



Figure 134: Channel1 (+), Channel2 (+), COM (-) Transistor Test

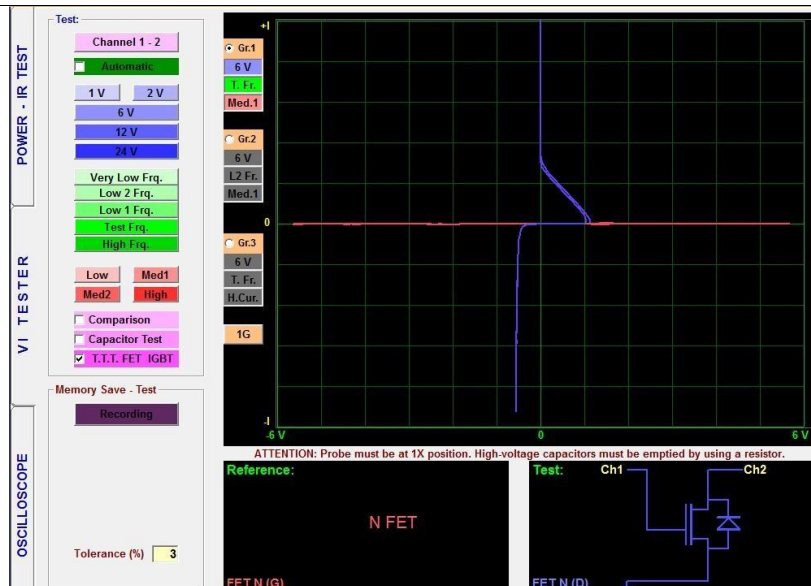


Figure 135: N FET VI Graph, Equivalent Circuit Diagram

## P FET

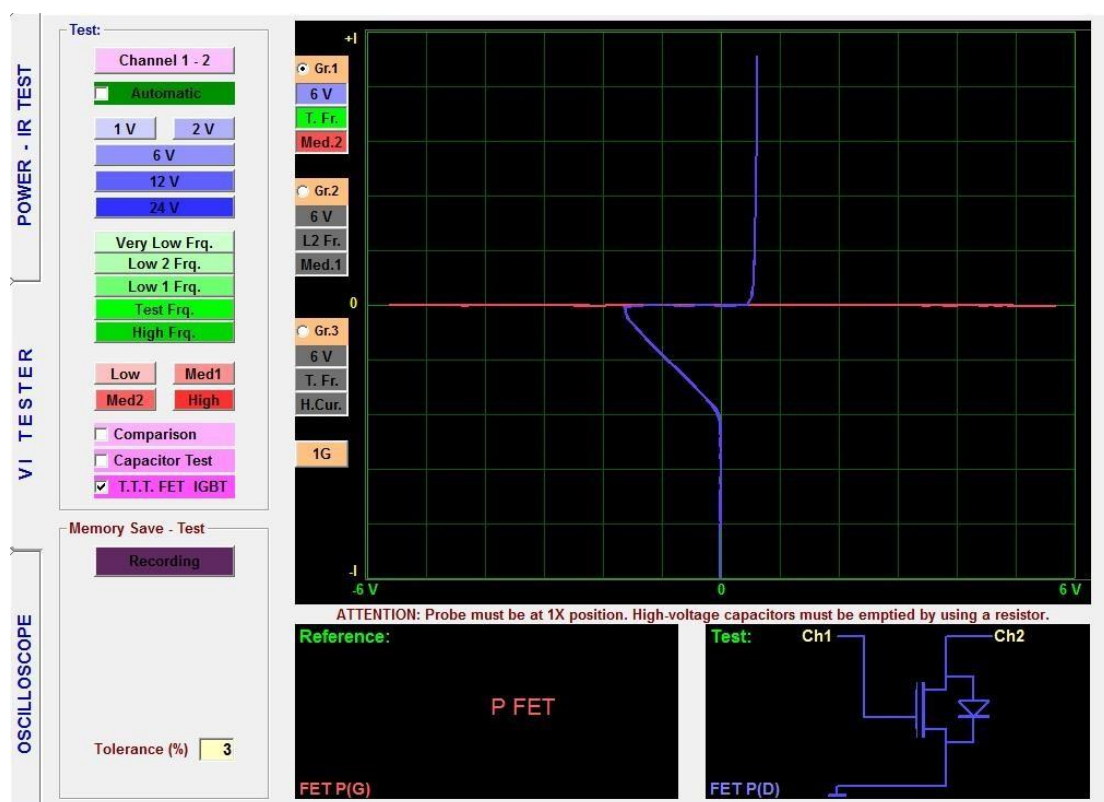


Figure 136: P FET VI Graph, Equivalent Circuit Diagram

Figure 137: Gate (+) Source (-) VI Graph

A capacitor effect is observed between the Gate and Emitter. When the gate pin is touched with the probe, the capacitor starts charging and when we remove the probe, the capacitor starts discharging. Depending on the charge and discharge state, that is the fullness condition, of the capacitor the following graphs may be observed during the Drain - Source test.

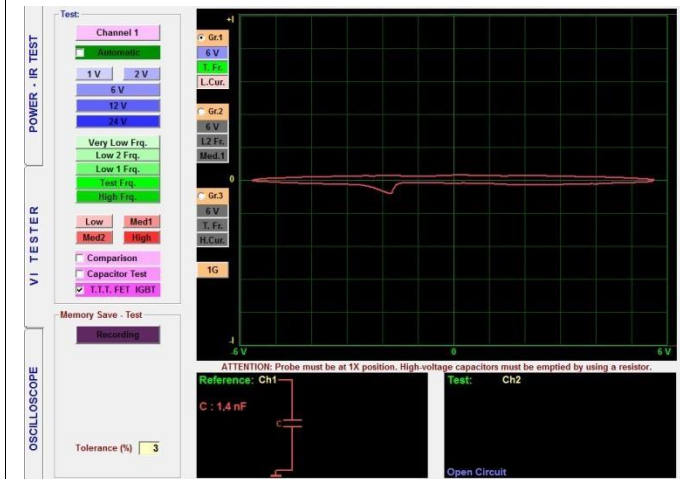


Figure 138: Drain (+) Source (-) VI Graph

The VI graph between Drain (+) and Source (-) is shown according to the fullness (charge) rate of the capacitor between the Gate and Emitter (charging).

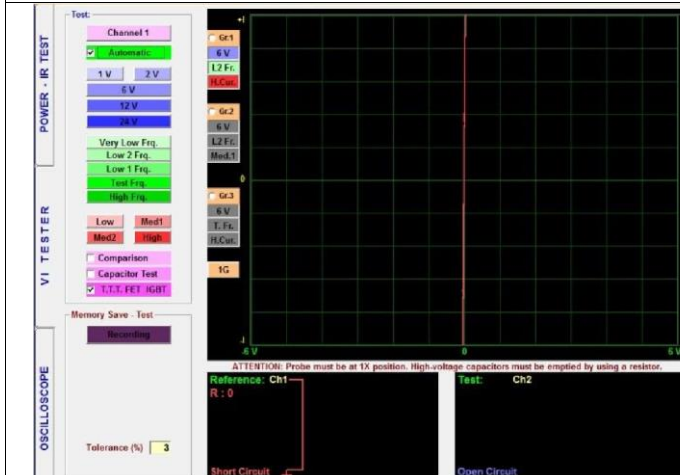


Figure 139: Drain (+) Source (-) VI Graph

The VI graph between Drain (+) and Source (-) is shown according to the fullness (charge) rate of the capacitor between the Gate and Emitter.

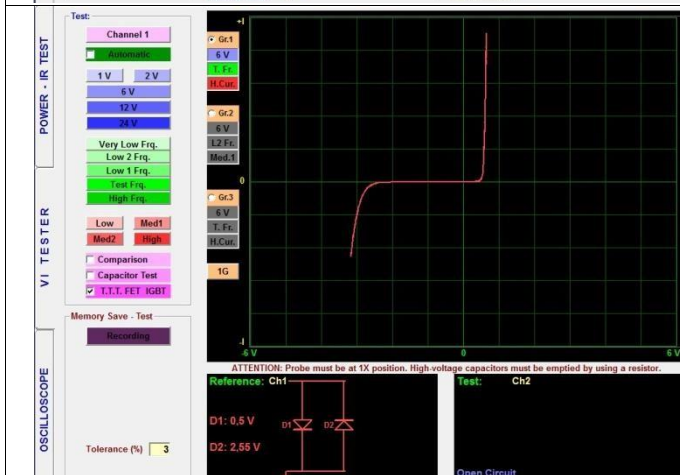
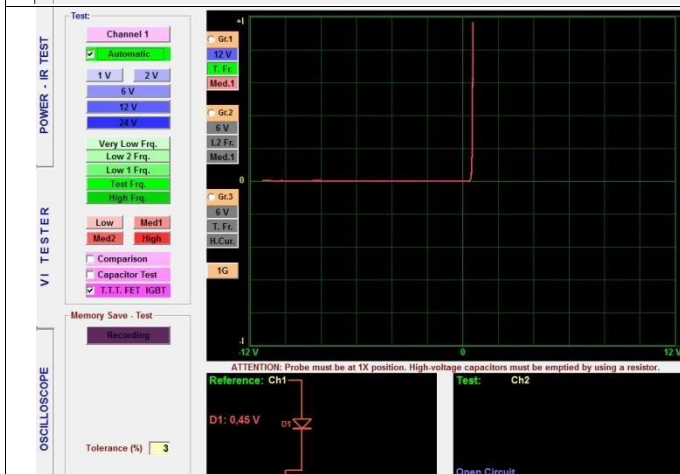


Figure 140: Drain (+) Source (-) VI Graph

The VI graph between Drain (+) and Source (-) is shown according to the fullness (charge) rate of the capacitor between the Gate and Emitter (discharging).





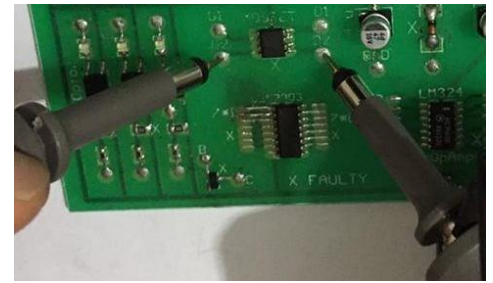
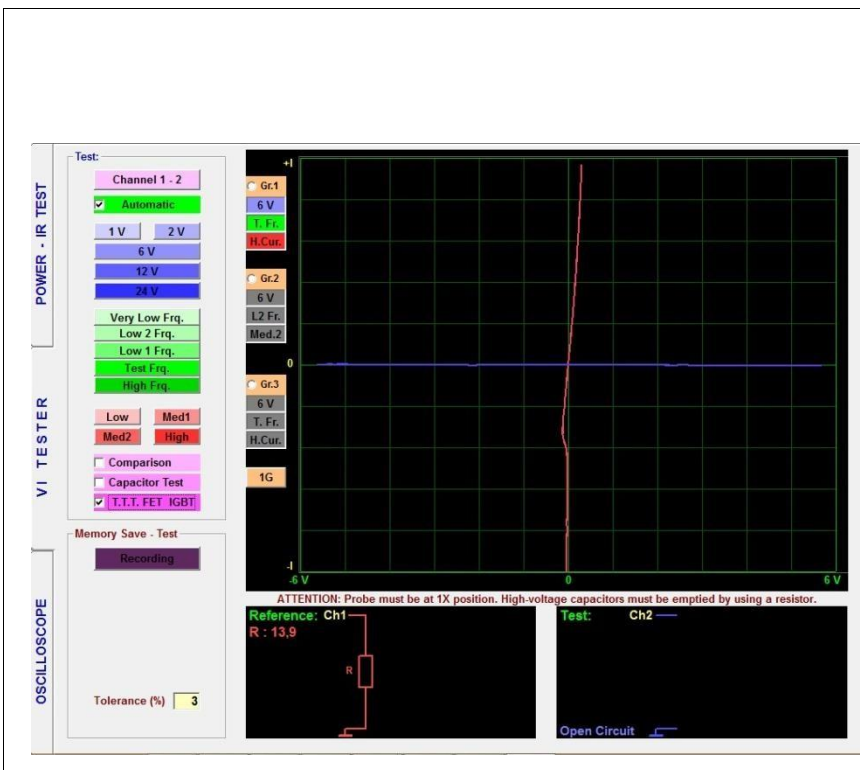


Figure 141: Sample of a Defective P Channel FET

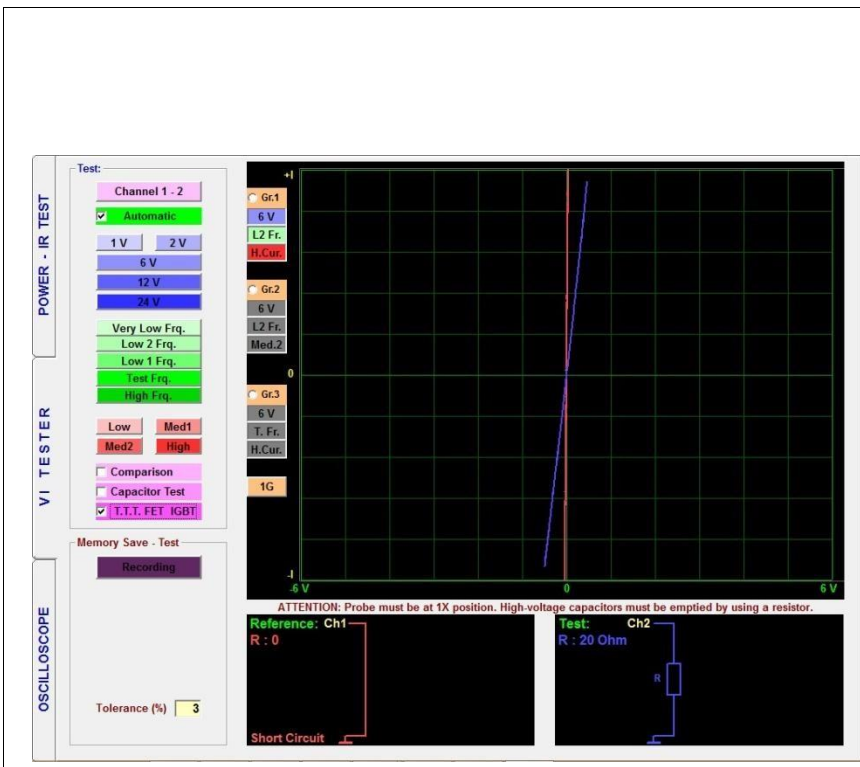


Figure 142: Sample of a Defective N Channel FET

## IGBT VI Graph

Insulated Gate Bipolar Transistor (IGBT) are comprised of a 3-pin semiconductor device. It is made of 4 layers (P-N-P-N) and is controlled by a metal oxide semiconductor (MOS). It is called an insulated transistor as well. It is mostly used in power circuits. Therefore, it is one of the first devices that comes to mind when we talk about power electronics. Its main function is switching and it executes the switching function very rapidly and effectively.



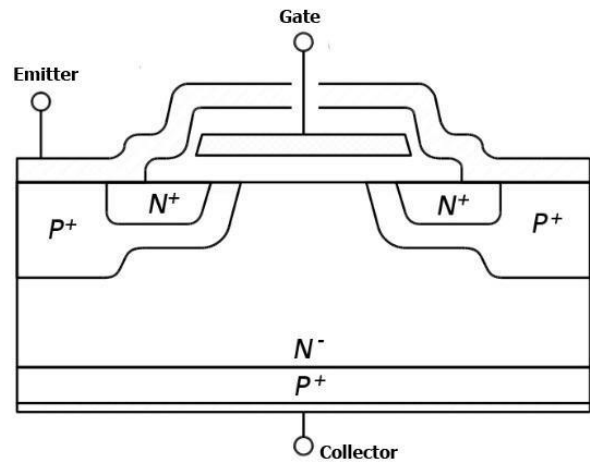
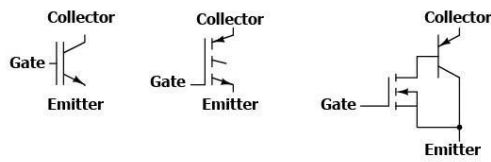


Figure 143: N type IGBT Schematic Symbol and Equivalent Circuit display

## IXGH 16N170 IGBT

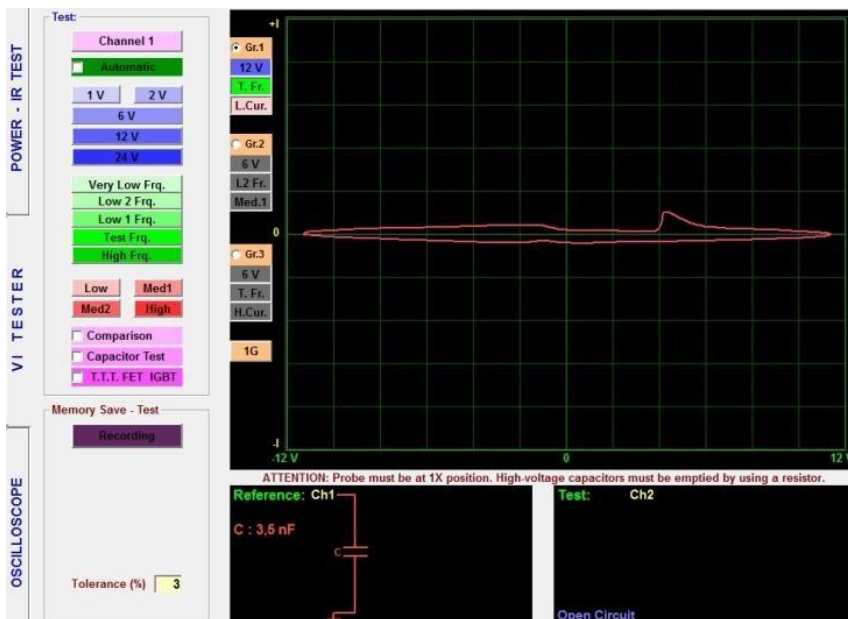


Figure 144: Gate (+) Emitter (-) VI Graph



Figure 145: Channel1 Probe Used for Gate - Emitter Measurement

In the IGBTs, the input impedance is high, and the internal capacitance between the electrodes is very low. Therefore, a capacitor effect is observed between the Gate and Emitter. When the

gate pin is touched with the probe as shown in Figure 144, the capacitor starts charging and when we remove the probe, the capacitor starts discharging. Depending on the charge and discharge state, that is the fullness condition, of the capacitor, the following graphs may be observed during the Collector - Emitter test.

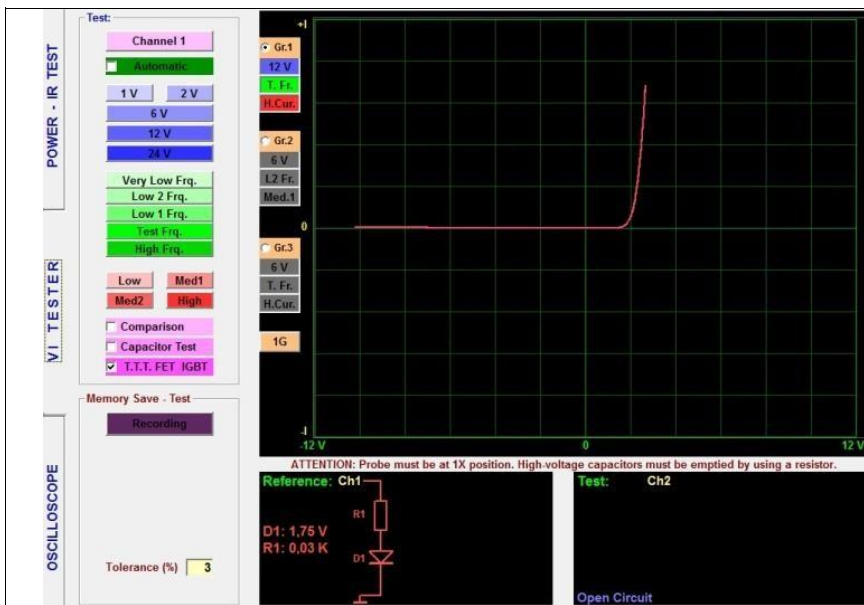


Figure 146: Collector (+) Emitter (-) VI Graph



Figure 147: Channel1 Probe Used for Collector - Emitter Measurement

The VI graph between Collector (+) and Emitter (-) is shown in Figure 146 according to the fullness (charge) rate of the capacitor between the Gate and Emitter (charging).

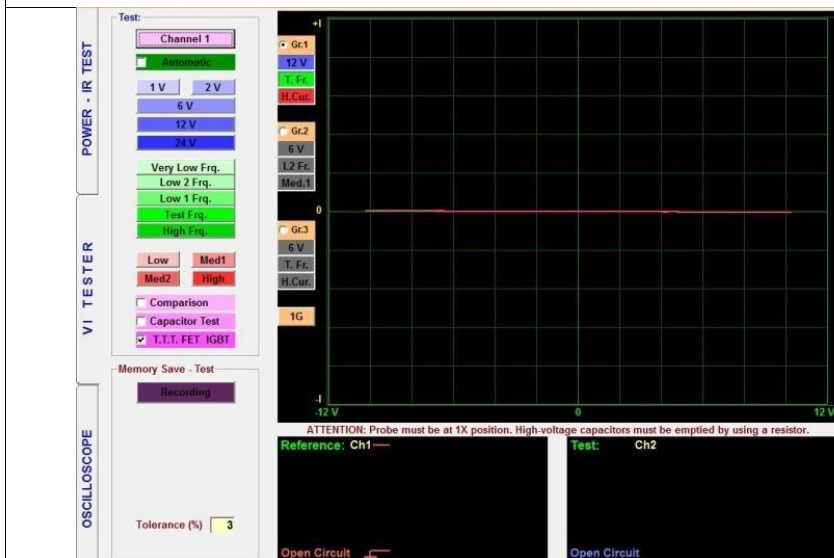


Figure 148: Collector (+) Emitter (-) VI Graph



Figure 149: Channel1 Probe Used for Collector - Emitter Measurement

The VI graph between Collector (+) and Emitter (-) is shown in Figure 148 according to the fullness (charge) rate of the capacitor between the Gate and Emitter (discharging).

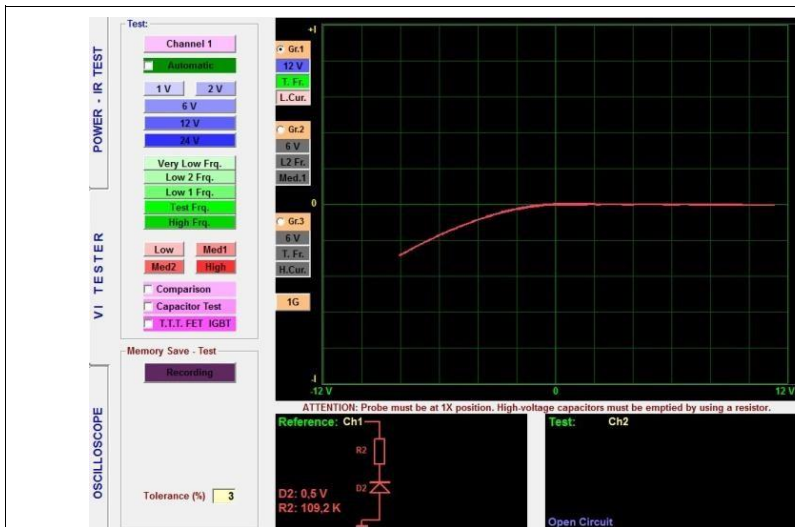


Figure 150: Collector (+) Emitter (-) VI Graph



Figure 151: Channel1 Probe Used for Collector - Emitter Measurement

The VI graph between Collector (+) and Emitter (-) is shown in Figure 150 according to the fullness (charge) rate of the capacitor between the Gate and Emitter (discharging).

**Note:** The appearance of the graphs may differ depending on the Voltage, current and frequency stages.

For example, in Figure 150, the voltage between the Collector (+) and Emitter (-) has been measured as 12V, measured at the test Frequency and Low current.

In Figure 148, the 12 V value in graph shown in Figure 150, it was measured at the test Frequency and High current.

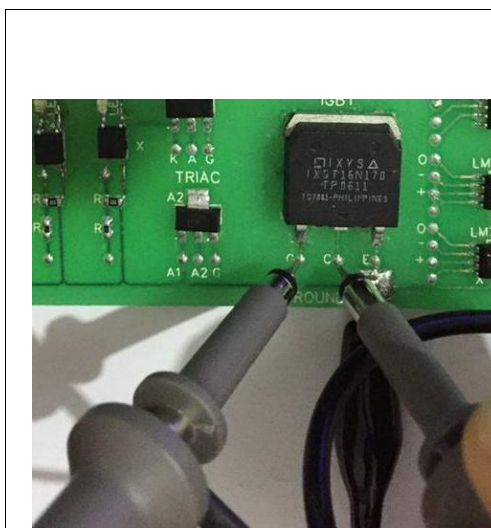


Figure 152: Channel1 (+), Channel2 (+), COM (-) IGBT Test



Figure 153: IGBT VI Graph, Equivalent Circuit Diagram

**Note:** In the Analog Signal Analysis, we have tried to illustrate the VI graphs of the same point (in the electronic material) at different voltage, frequency or current stages. The VI graphs may

give different responses against different test stages. For example, an electronic material that does not conduct under high current may start conducting under low current etc. Those conditions are illustrated in Figure 148 and Figure 150.

### Thyristor (SCR) VI Graph

The Thyristor structure is composed of four consecutive layers of P type and N type semiconductors. The two of the three pins of the thyristor are the anode at the P type semiconductor portion and a cathode at the N type semiconductor and the other is connected to the Gate extending from the P type section closer to the cathode.

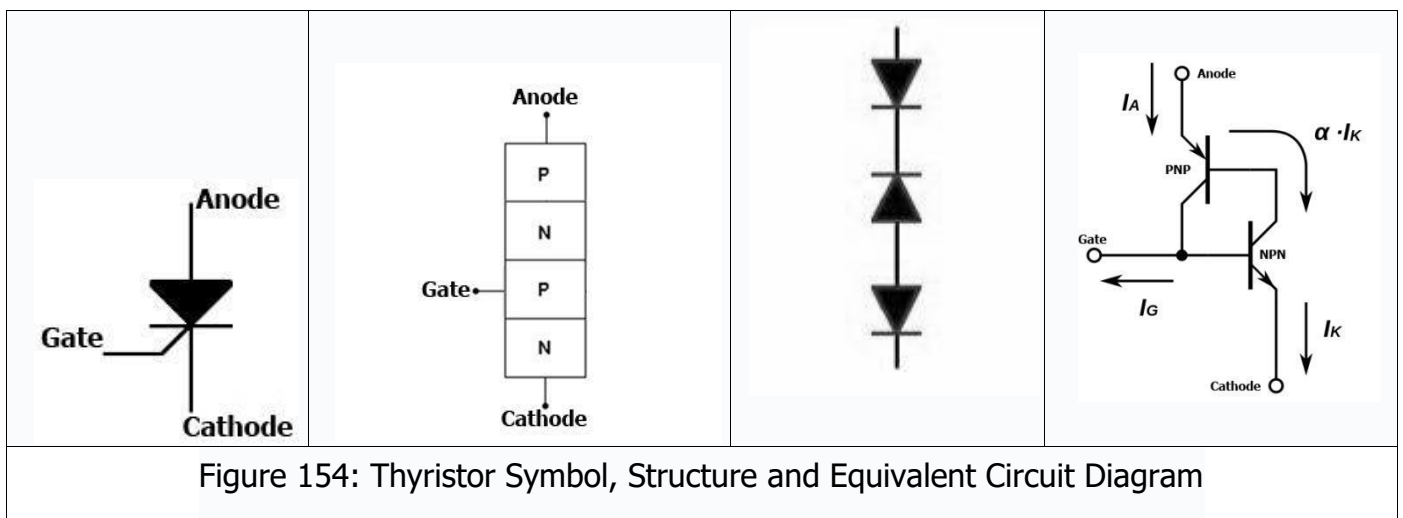






Figure 155: Channel1 Probe Used for Gate - Cathode Measurement

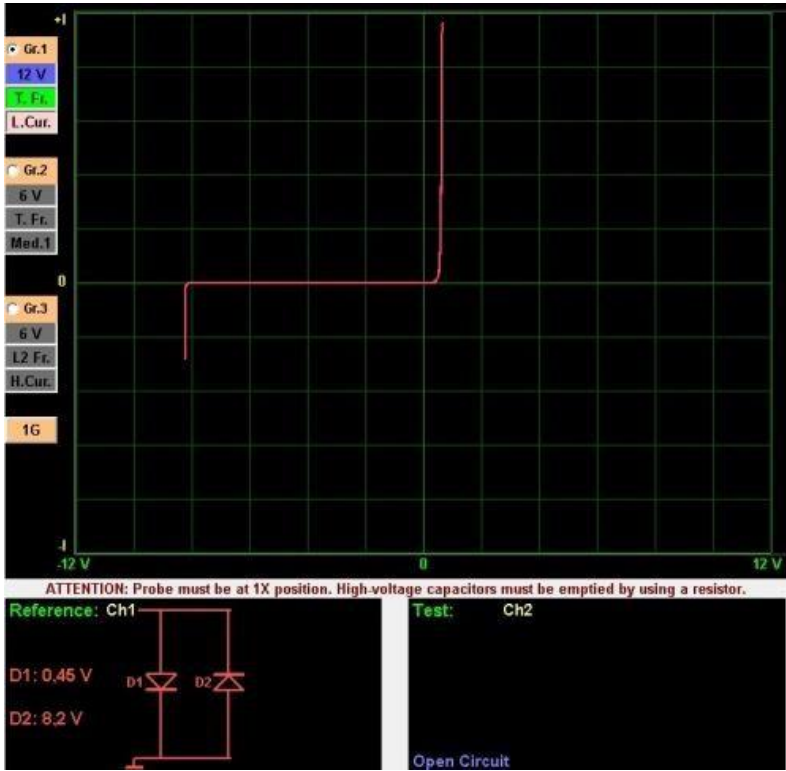


Figure 156: Gate (+) Cathode (-) VI Graph

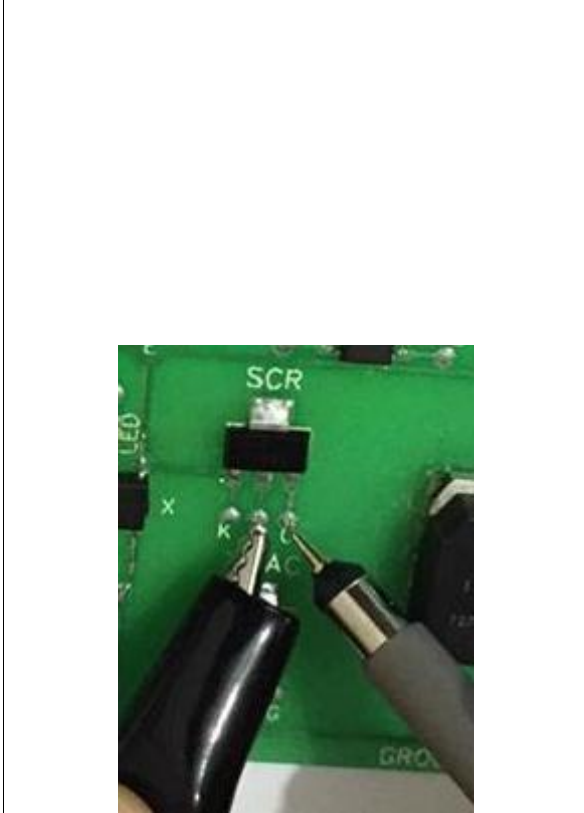


Figure 157: Channel1 Probe Used for Gate - Anode Measurement



Figure 158: Gate (+) Anode (-) VI Graph



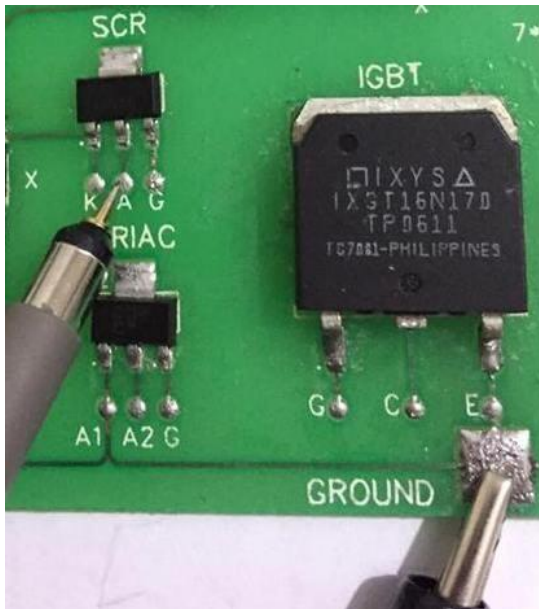


Figure 159: Channel1 Probe Used for Anode - Cathode Measurement

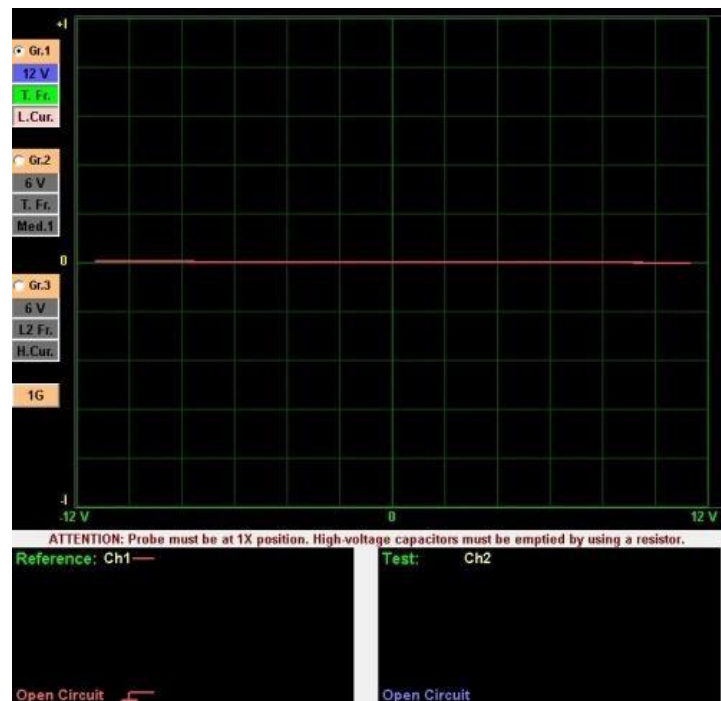


Figure 160: Anode (+) Cathode (-) VI Graph



Figure 161: Channel1 (+), Channel2 (+), COM (-) Thyristor Test

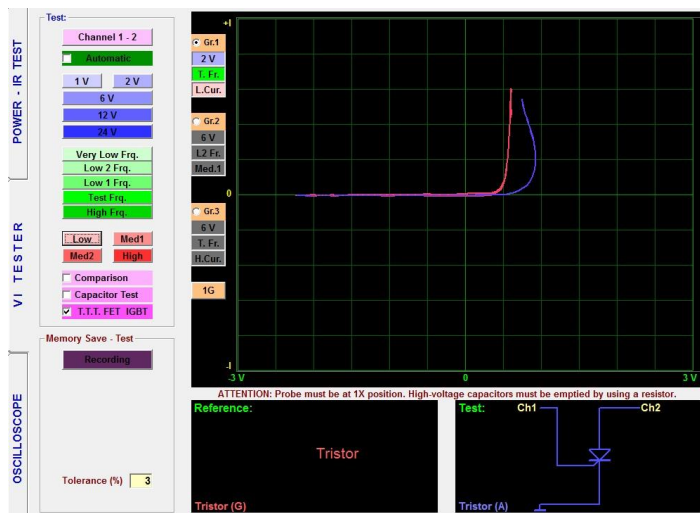


Figure 162: Thyristor VI Graph Equivalent Circuit Diagram

**Triac VI Graph**

The Triac is composed of two thyristors of N gate and P gate connected to each other in reverse and is a semi conductor device that conducts the alternating current in both directions. It has a more advanced construction than the thyristor. The triac is also a circuit component used in power electronics like the thyristor.

It has 3 pins as the A1 (Anode 1), A2 (Anode 2) and Gate. The triacs can operate on both DC and AC voltage.

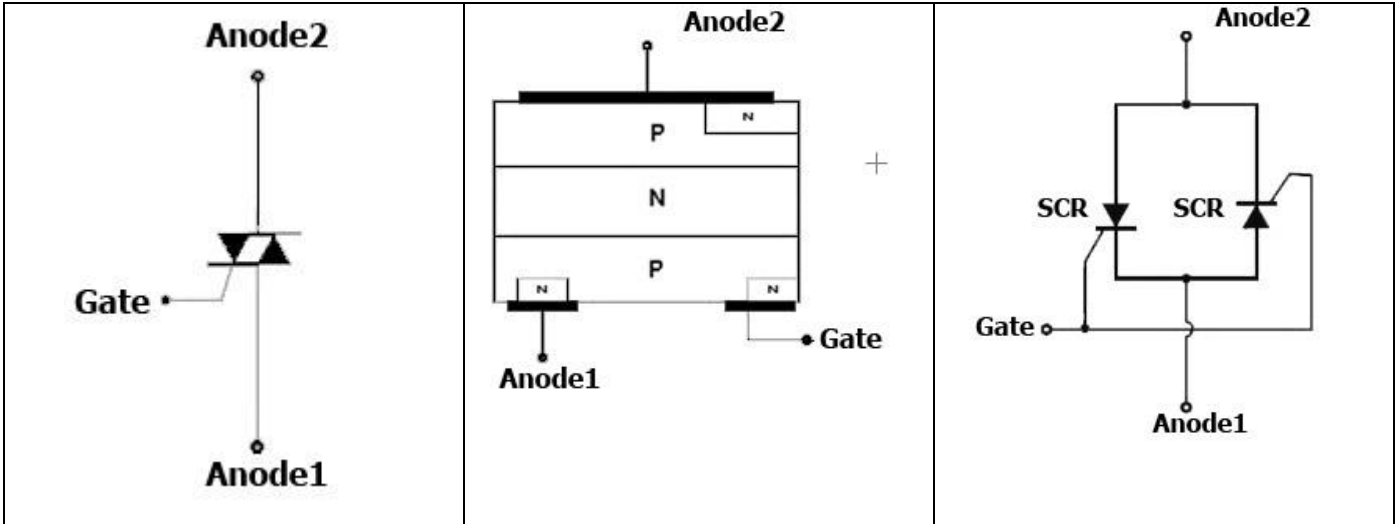


Figure 163: Triac Symbol, Structure and Equivalent Circuit Diagram

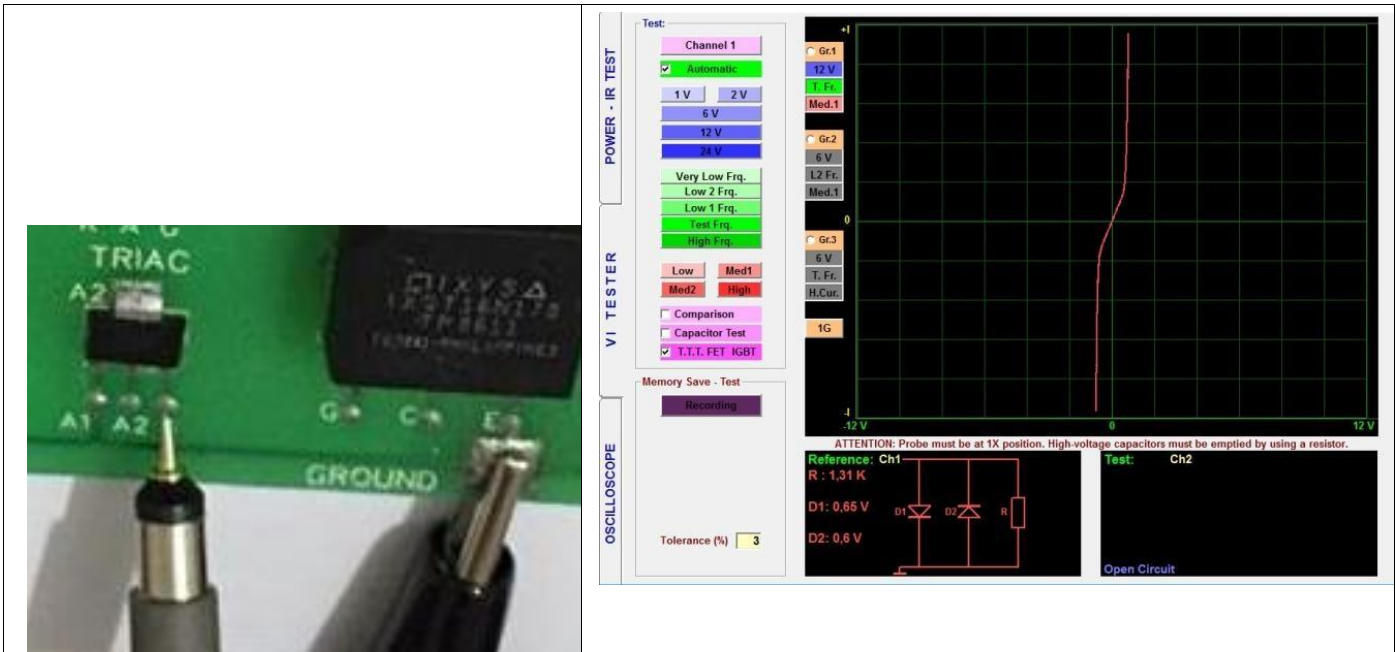


Figure 164: Channel1 Probe Used for Gate - Anode1 Measurement

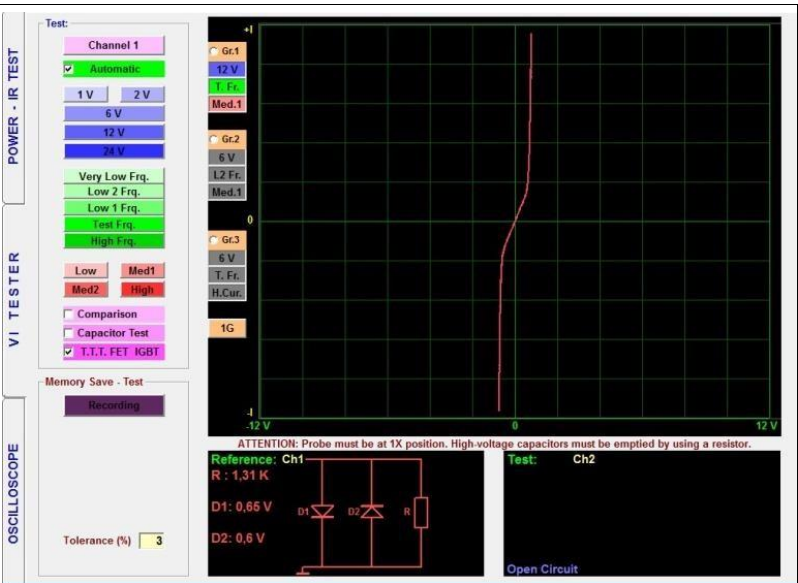


Figure 165: Gate (+) Anode1 (-) VI Graph



Figure 166: Channel1 Probe Used for Gate - Anode2 Measurement

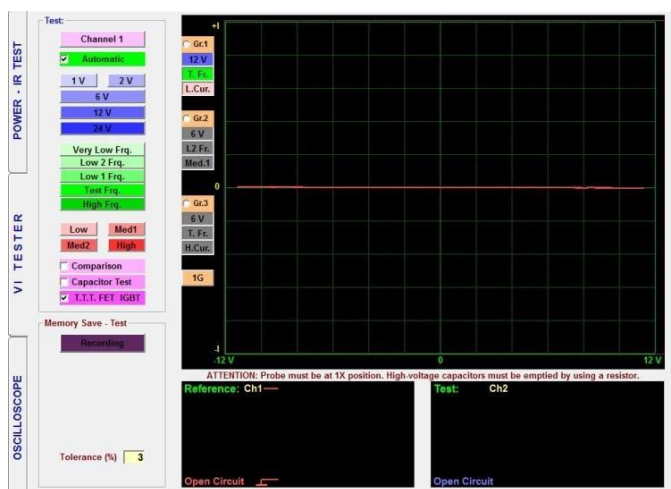


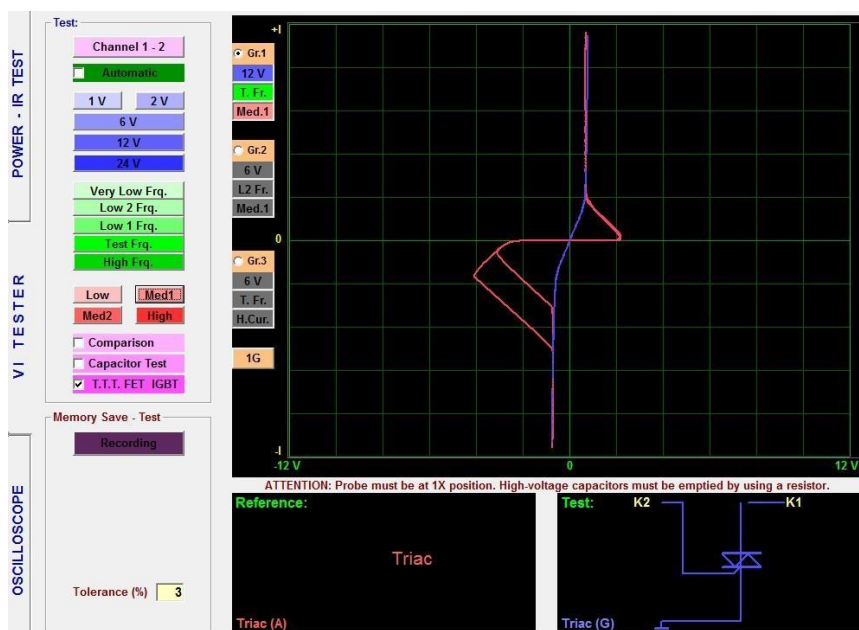
Figure 167: Gate (+) Anode2 (-) VI Graph



Figure 168: Channel1 Probe Used for Anode2 - Anode1 Measurement



Figure 169: Anode2 (+) Anode1 (-) VI Graph



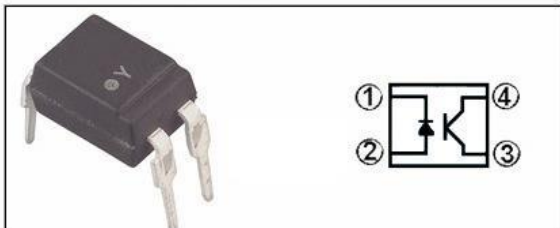
## Opto-coupler VI Graph

The Opto-couplers are the circuit components that are composed of a light emitting and a photo-receiver element with optical connection between each other and are used for controlling high voltage and current by means of low voltages without any electrical connection to isolate the two circuits electrically.

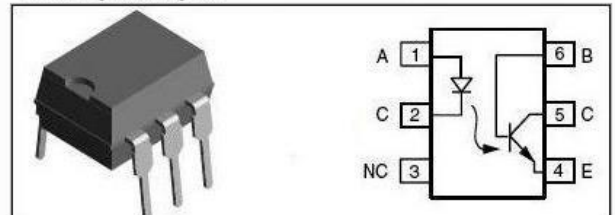
The function of the opto-coupler is separating two circuits physically from each other, that is isolating them electrically. As an example, in the circuits, where 12 V and 220 V are used, optocouplers are used for keeping those two different voltages separately. Thanks to the optocouplers, different currents in the same circuit are isolated from each other to ensure a safe current flow and faultless operation of the circuit.

They may have different structures from Transistor, triac, mosfet, thyristor, ttl, logic and cmos to darlington, parallel connection etc. Some of them may have extra triggering pins for use in special external applications. For example, the PC817 has 4 pins, of which two are for the LED and the other two forms the base pin for the collector and emitter of the transistor and there is no separate pin for the base. The 4N25 has 6 pins, one of which is for the base.

**PC817 Optocoupler**



**4N25 Optocoupler**



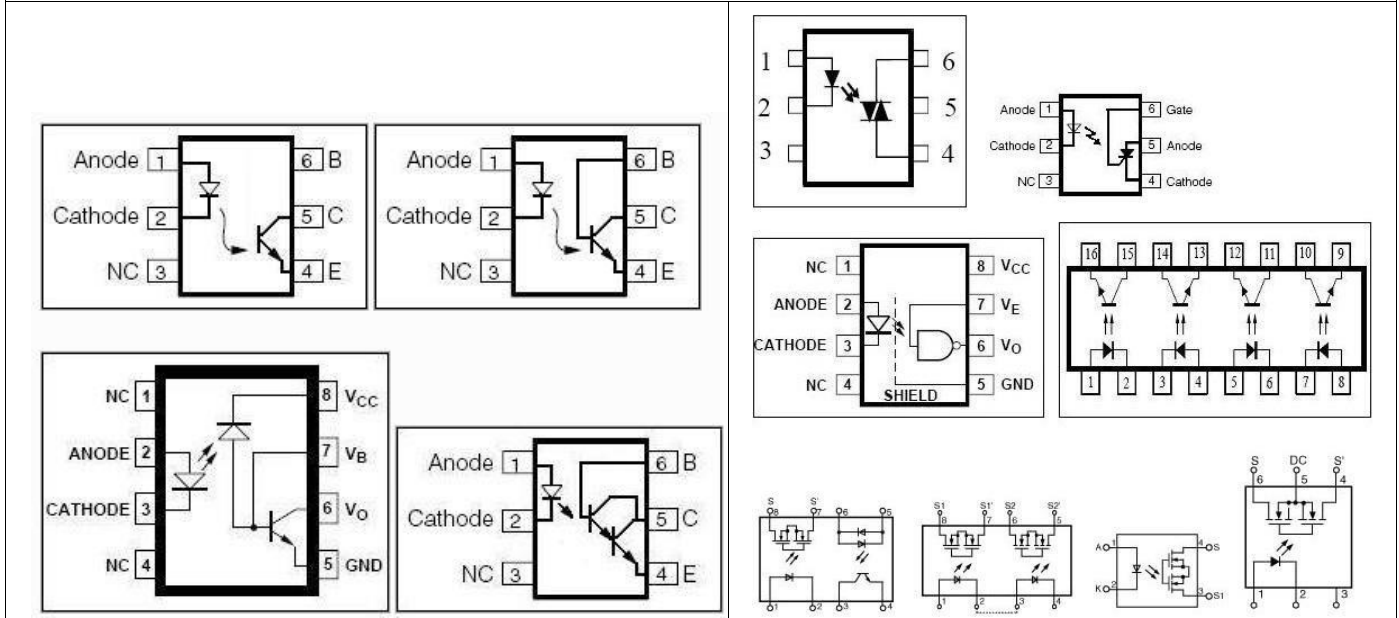


Figure: 172 Opto-coupler Symbol and Equivalent Circuit Diagram

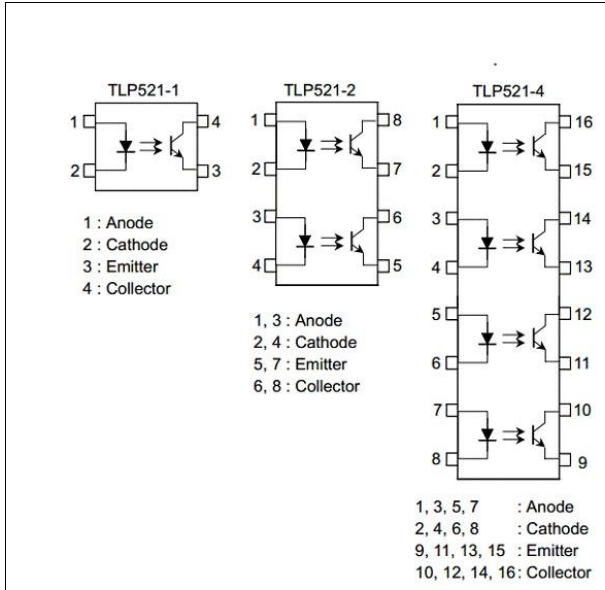


Figure 173: TLP521-X Opto-coupler Equivalent Circuit Diagram



Figure 174: TLP521-1, TLP521-2, TLP521-4 Opto-coupler



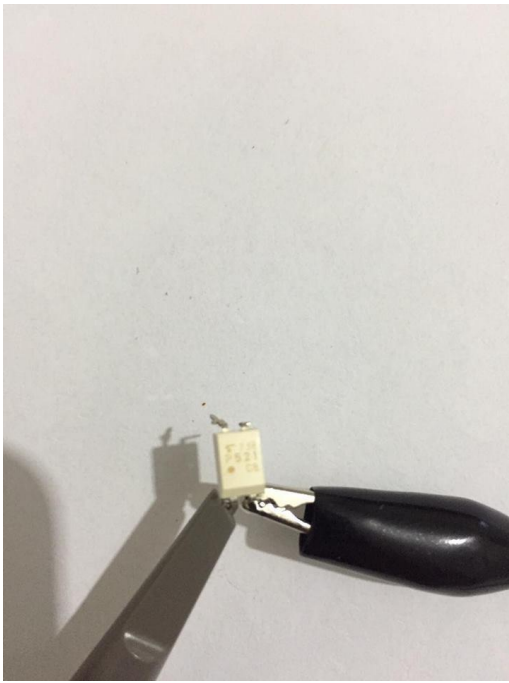


Figure 175: TLP521-1 Test Channel2 (Anode) - COM (Cathode)

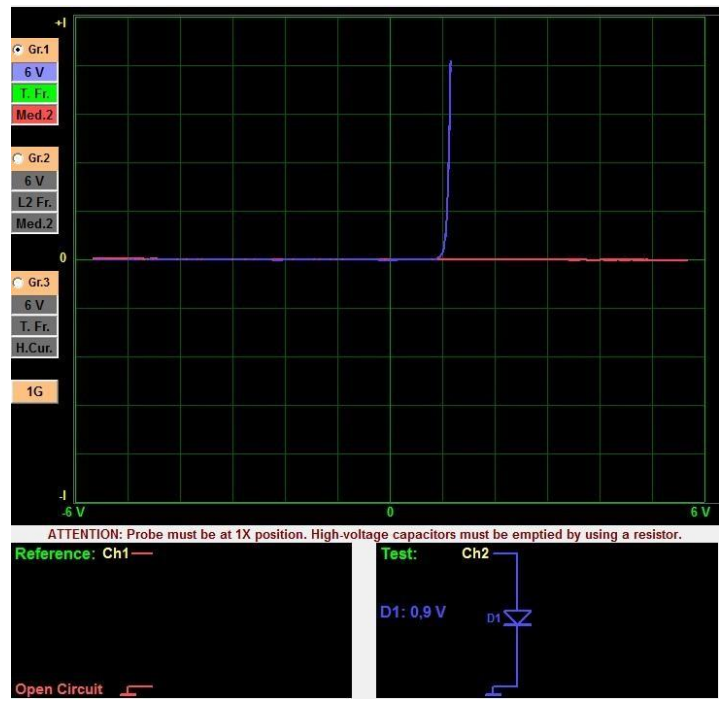


Figure 176: TLP521-1 Test Channel2 (Anode) - COM (Cathode) VI Graph

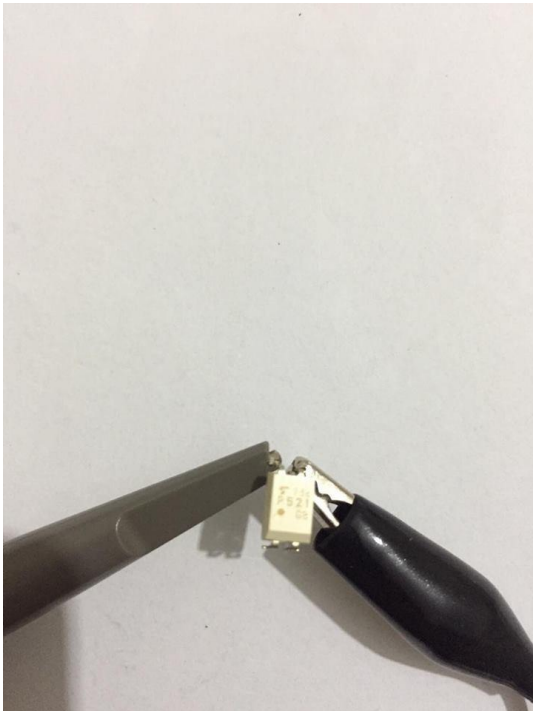


Figure 177: TLP521-1 Test Channel1 (Collector) - COM (Emitter)

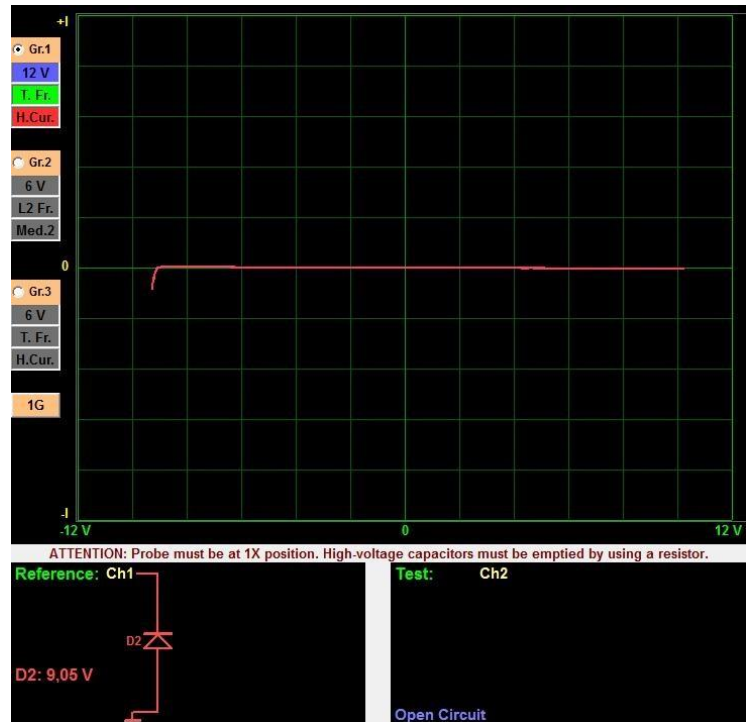


Figure 178: TLP521-1 Test Channel1 (Collector) - COM (Emitter) VI Graph

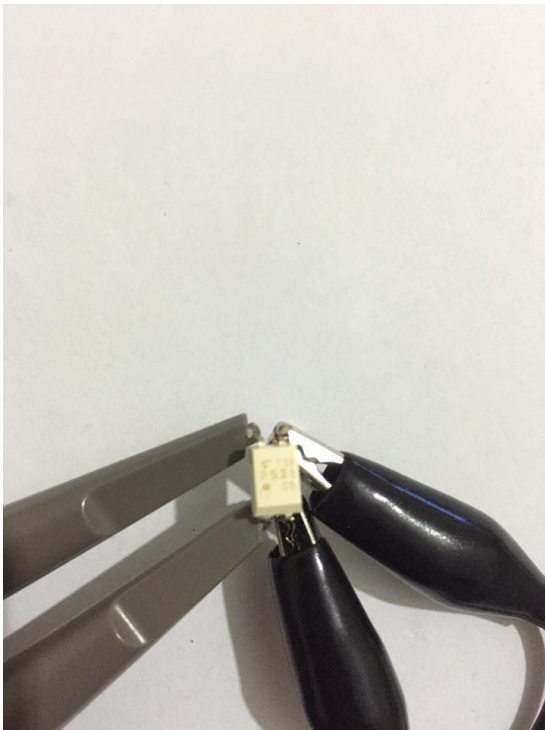


Figure 179: TLP521 - 1 Test Channel1 (Collector) - COM (Emitter), Channel2 (Anode) - COM (Cathode)

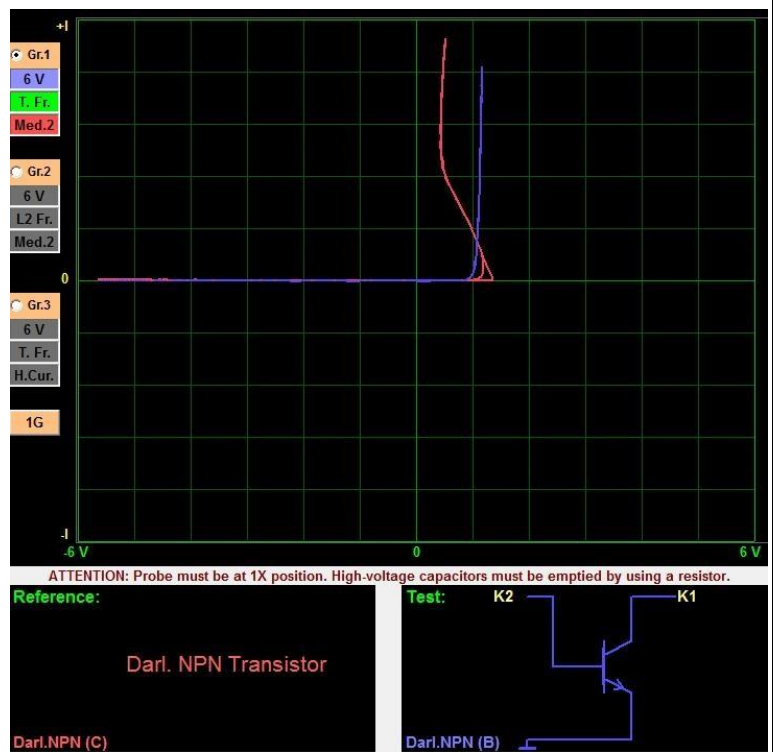


Figure 180: TLP521-1 Opto-coupler VI Graph

**Note:** TLP521-2 Optocoupler is comprised of 2 x TLP521-1 Opto-coupler and the TLP521-4 Optocoupler is comprised of 4 x TLP521-1 Opto-couplers. After examining the data sheet, the pins with the same names and same functions are compared to each other for testing.

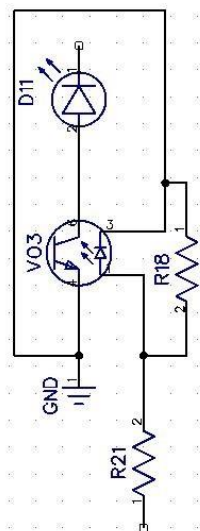
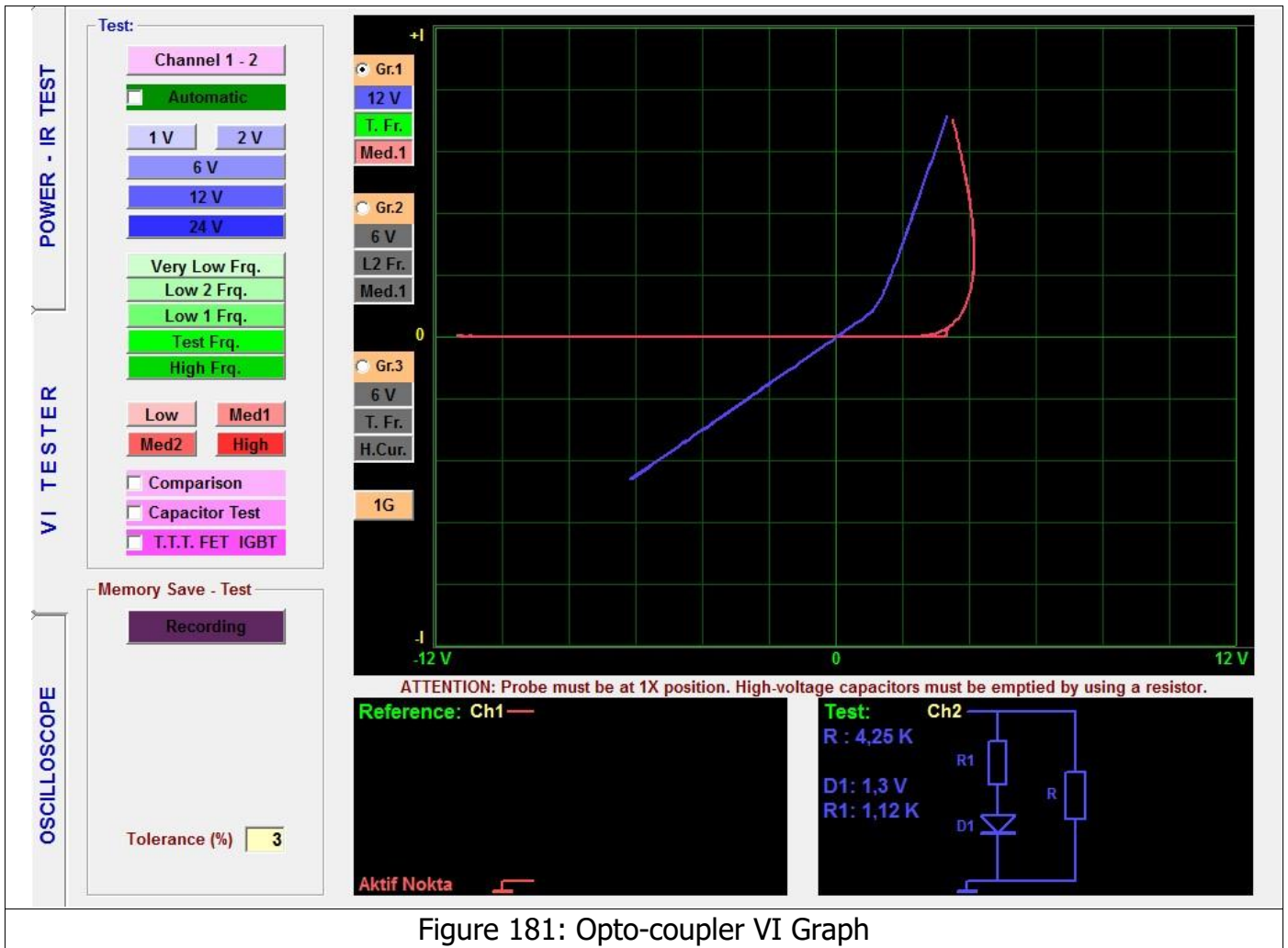


Figure 182: IS181GB Opto-coupler Circuit

**Note:** Figure 181 shows the VI graph of the IS181GB opto-coupler in the circuit given on the left side. A signal is applied to the V03 optocoupler in the circuit over the resistor R21 (Channel2); we can understand when the opto-coupler starts conducting from the diode D11 (LED). This can check if the LED is conducting by touching the Channel1 probe to the cathode pin of the diode D11. If the LED conducts, the opto-coupler is intact.

## INTEGRATED CIRCUITS (ICs – SMD INTEGRATED CIRCUIT TESTS)

The Integrated circuits are composed of the semiconductor components and protective Zener diodes and or diodes are connected to all the pins for protection. Therefore, when the integrated circuits are tested, their VI graphs resemble the Zener diodes or normal diodes. The VI graph of the Integrated circuit Vcc pin resembles the graph of a diode and a capacitor connected in parallel. The graph of a short circuit is displayed for the GND pin.

While testing the Integrated circuits in the circuit, because the integrated circuit pins are connected to the other components in the circuit, the graphs of the IC pins may look like the graphs for the components connected to the Zener diode (or diode) in parallel or in series. While testing an integrated circuit (except the short circuit test), IC shorting the Vcc and GND pin of the Vcc together is recommended. Connect the Crocodile probe to the GND pin and touch the IC pins with the probe for testing. If the Integrated circuit pins do not display the graphs for the zener or diodes, the integrated circuit pin is damaged and so the integrated circuit (IC) is damaged.

The Digital integrated circuits contain more than one components of the same type. Although they may have more than one pins, they may yield several different VI graphs. The data sheets of the Digital integrated circuits are checked for testing the pins that give the same output or have the same inputs (the pins with the same functions and names) against each other.

For example, when we examine the data sheet for the 74LS02 IC;

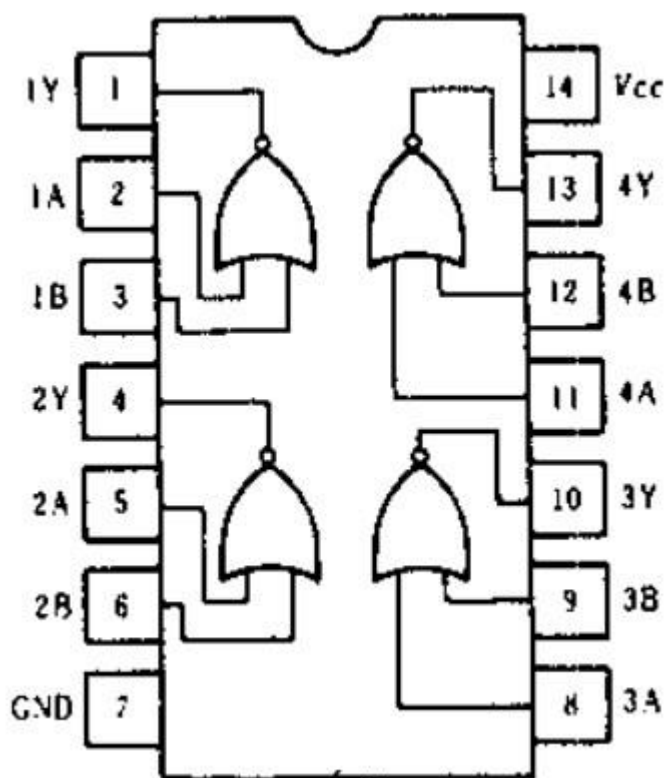


Figure 183: 74LS02 Pin Configuration

The 74LS02 integrated circuit is comprised of 4 NOR gates with 2 inputs positive. When we examine the Integrated circuit datasheets, there are four different connections as the input, output, Vcc (power) and ground. There are 4 NOR gates with 2 inputs (A and B pins) and an output (Y pin). The Pins 2,3,5,6,8,9,11,12 are the input pins and their VI graphs should be identical. The Pin 1, 3, 10 and 13 are the output pins and their VI graphs should be identical. The Pin 14 is Vcc and Pin 7 is the GND. We can find the defective pin easily by comparing the pins with the same graph against each other.

The VI graphs for the 74LS02 IC is shown below. When the integrated circuits are tested outside the circuit, connect the COM probe or crocodile of probe to the Ground pin. The Ground and Vcc pins can also be short circuit and connect the crocodile. For the example below, the Vcc pin and GND pin were shorted together.

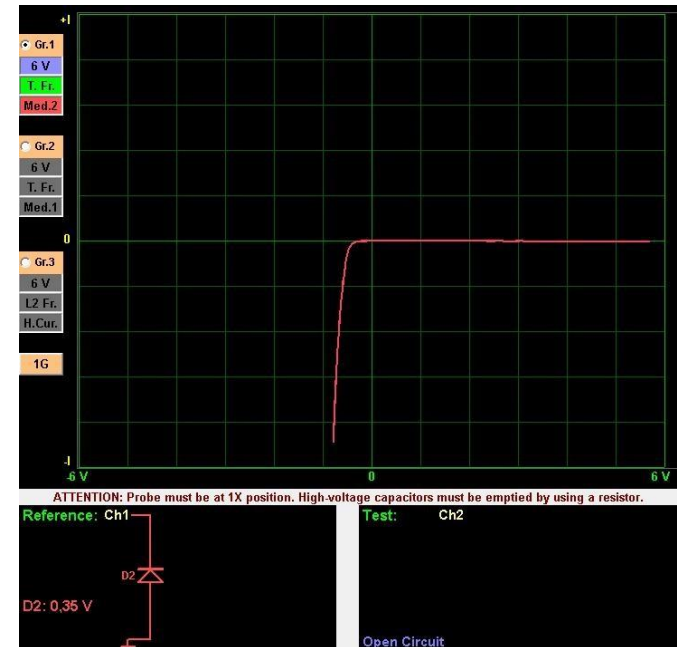


Figure 184: 74LS02 Input VI Graph

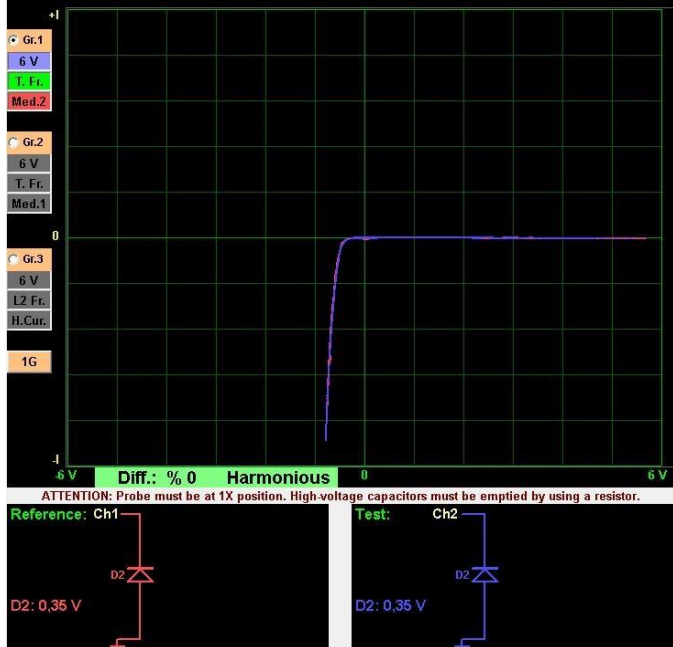


Figure 185: 74LS02 Input VI Graph Comparisons Against Each Other



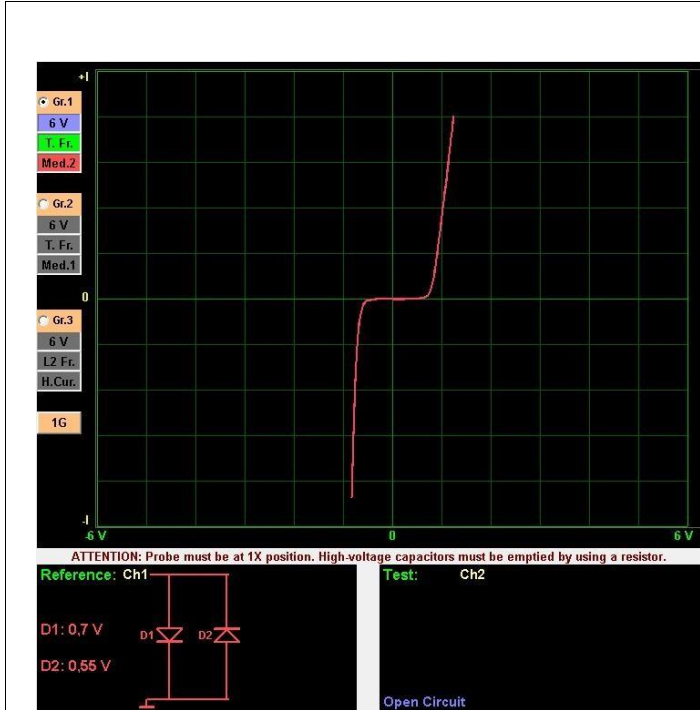


Figure 186: 74LS02 Output VI Graph

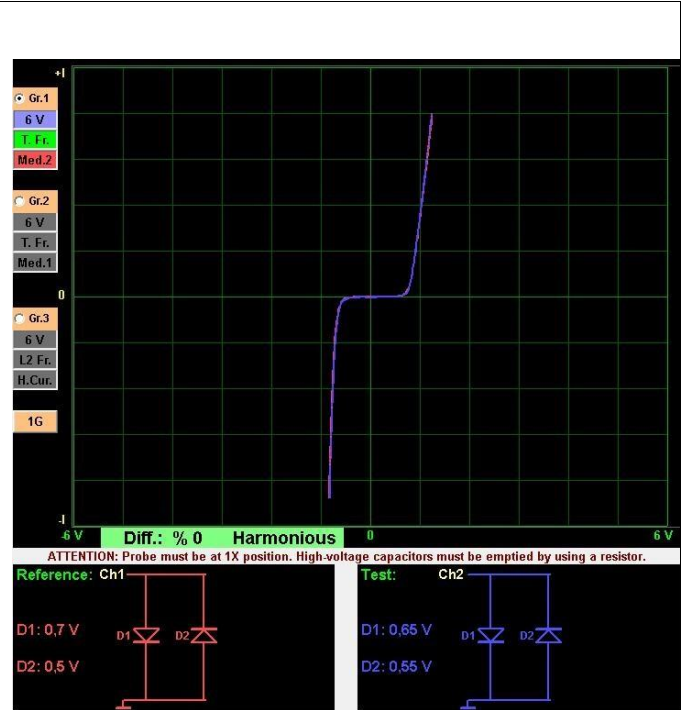


Figure 187: 74LS02 Output VI Graph Comparisons Against Each Other

The Analog integrated circuits are called the “op amps” in general. We may see a different VI graph for each pin. The reason for that is the particular architecture of the IC and the connection of the components used in the IC to each other. Like the Digital integrated circuit tests, the pins with the same names and functions in the analog integrated circuits should be the same VI graphs. For example, when we examine the datasheet for the ULN2003 analog IC, it has 7 inputs (1,2,3,4,5,6,7 pins) and 7 outputs (10,11,12,13,14,15,16 pins). The Input and outputs should have the same VI characteristic curves respectively. The pins with the same names and functions are tested by comparing them to each other.

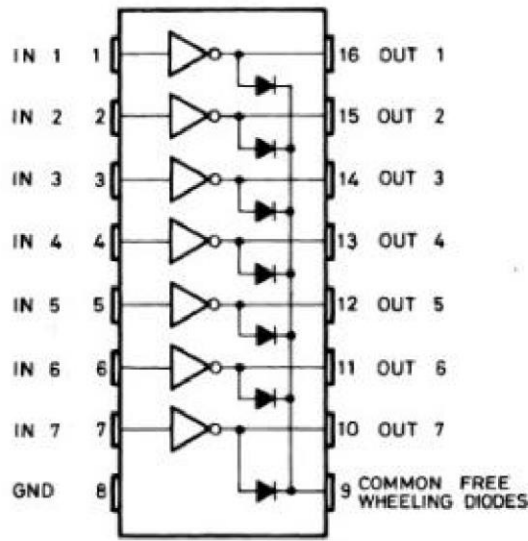


Figure 188 : ULN2003 Pin Configuration

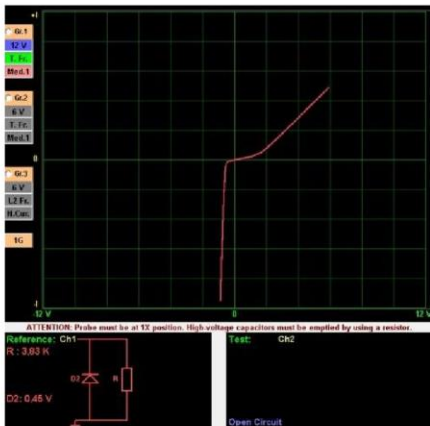


Figure 189 : ULN2003 Input VI Graph

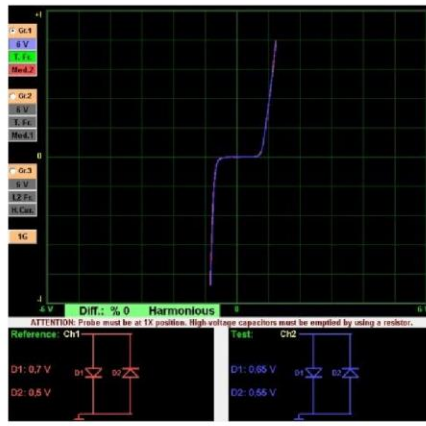


Figure 190 : ULN2003 Input VI Graph Comparisons Against Each Other (Intact Pin)

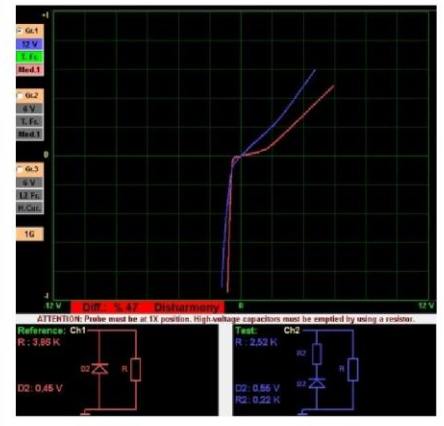


Figure 191 : ULN2003 Input VI Graph Comparisons Against Each Other (Defective Pin)

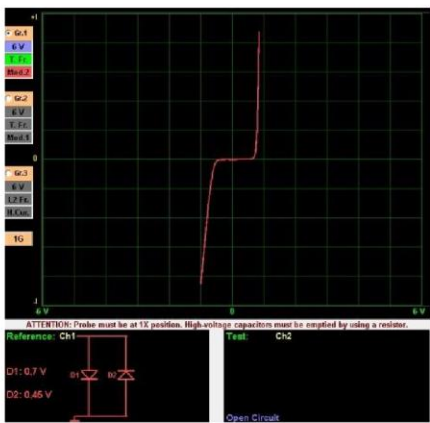


Figure 192 : ULN2003 Output VI Graph

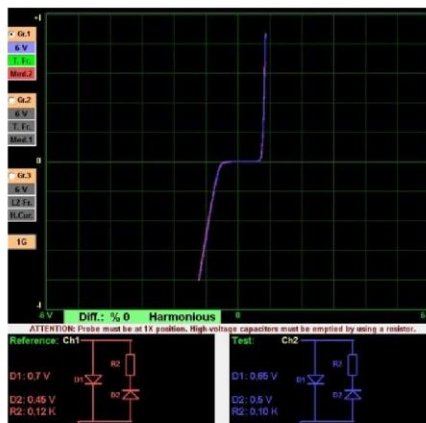


Figure 193 : ULN2003 Output VI Graph Comparisons Against Each Other (Intact Pin)

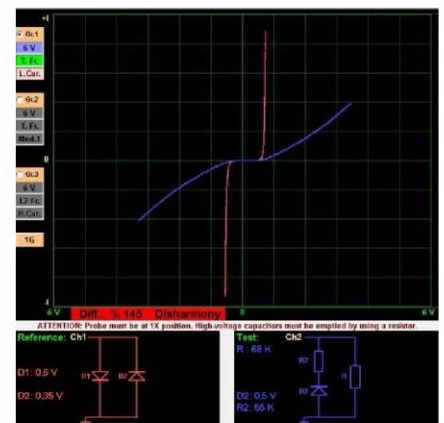


Figure 194 : ULN2003 Output VI Graph Comparisons Against Each Other (Defective Pin)

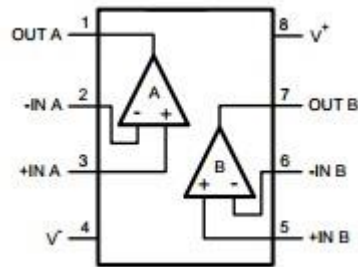


Figure 195: LM732 2MA Pin Configuration

The LM732 2Ma is an op-amp with 2 outputs. The Integrated circuit has 2 opamps inside. We can compare those op-amps against each other. That is, we can compare the Pin 2 and Pin 6 (non-inverting); Pin 3 and Pin 5 (inverting) and Pin 1 and Pin 7 (output) against each other respectively.

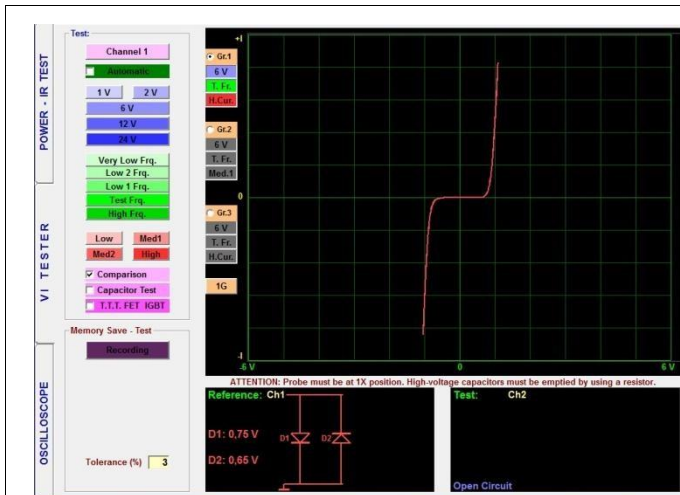


Figure 196: LM732 2MA In (+) VI Graph

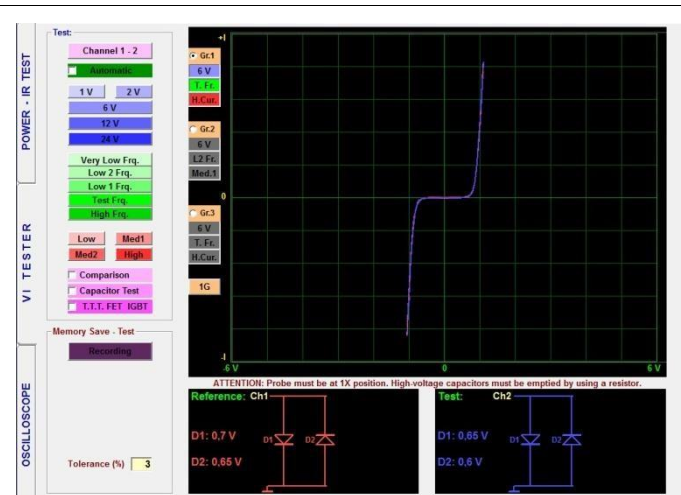


Figure 197: LM732 2MA In (+) VI Graph Comparisons Against Each Other (Intact Pin)

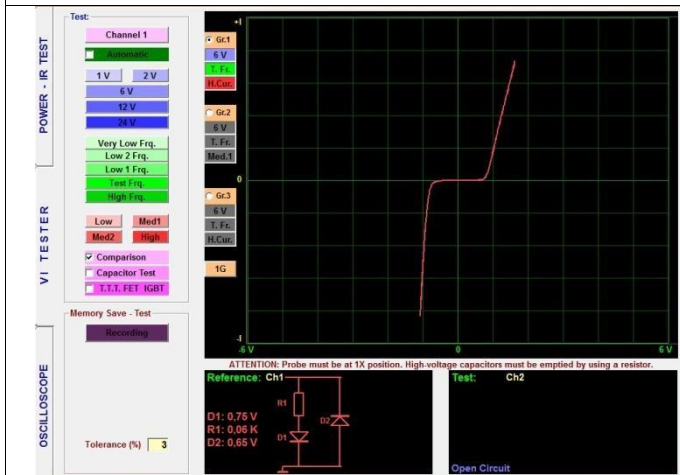


Figure 198: LM732 2MA In (-) VI Graph

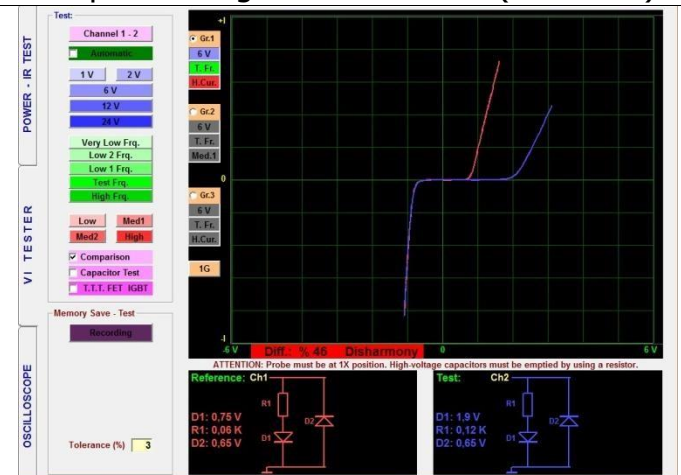


Figure 199: LM732 2MA In (-) VI Graph Comparisons Against Each Other (Defective Pin)

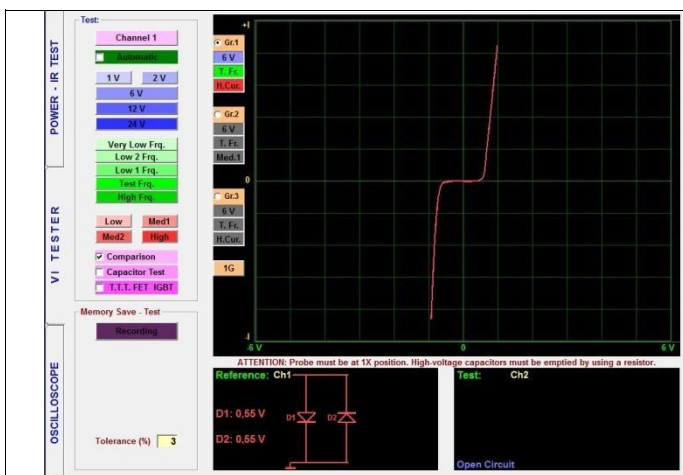


Figure 200: LM732 2MA Out VI Graph

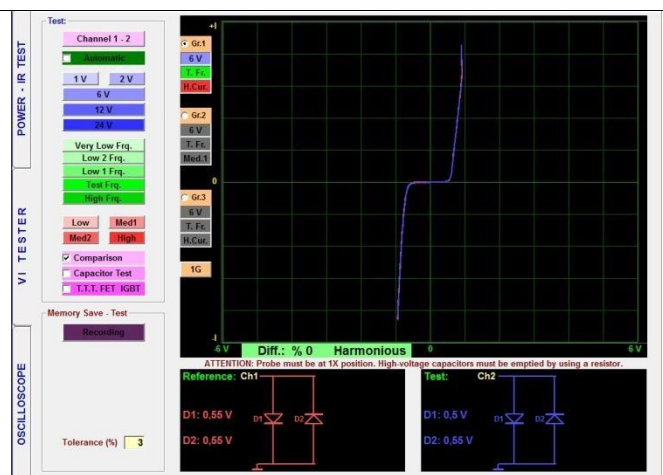


Figure 201: LM732 2MA Out VI Graph Comparisons Against Each Other (Intact Pin)

The best way of troubleshooting the op-amps is comparing the graph of an op-amp that is known to be intact with the graph of the defective or suspect op-amps.

**Note:** Some manufacturing differences may be present in the integrated circuits and therefore, the signals inside the circuits cannot be guaranteed since the production processes may differ, despite using similar production methods. To make the comparisons, use the ICs from the same manufacturers, because the integrated circuits from different manufacturers may yield different signal forms. Saving the signal forms in the computer may make the subsequent works easier.

## Regulator Integrated Circuits

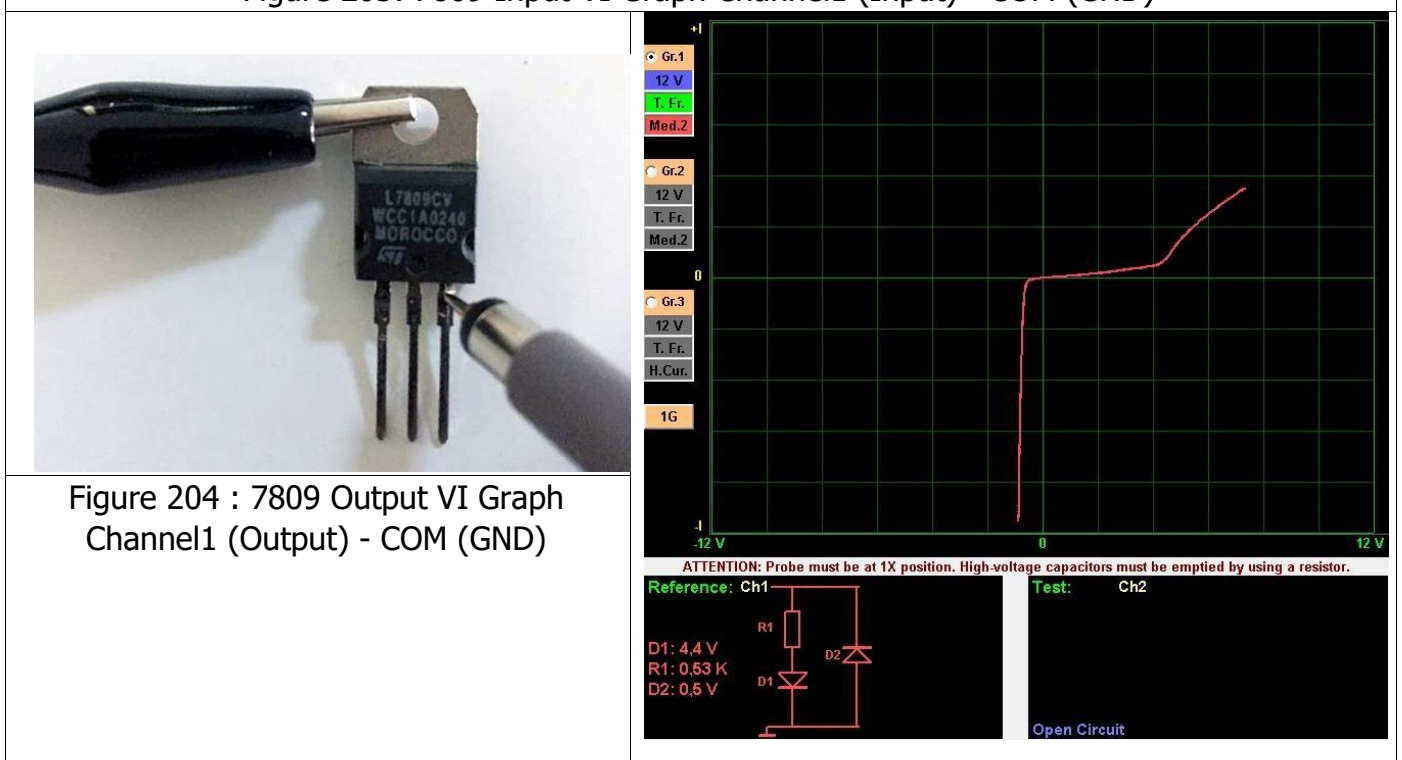
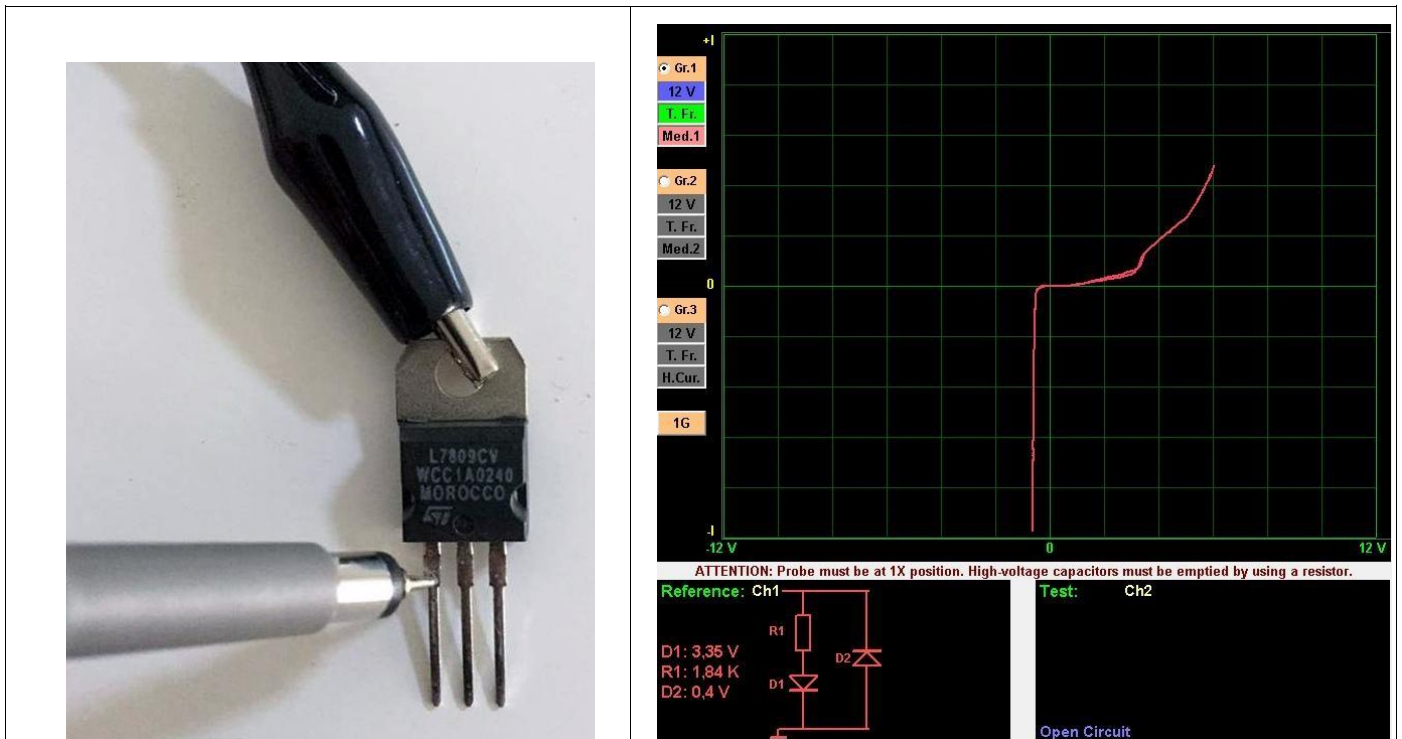
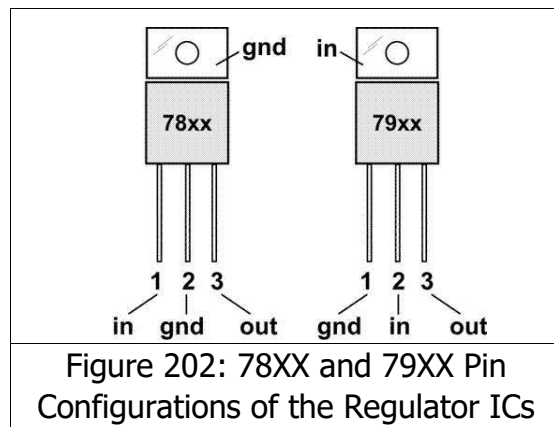
A Regulator circuit means a circuit that maintained the output voltage or current at a fixed value. They may also be called "Regulation circuits" or "Regulators".

The 78XX integrated circuits are electronic components used in the regulator circuits that provide a positive (+) output. They can handle up to 1 Ampere of current. The purpose of the regulator is providing a fixed positive output regardless of the input voltages (within certain limits). The Output voltages are written in the XX part. The 78 part denotes a + voltage output. For example, a 7805 integrated circuit will produce a fixed 5V output from a 612V volt input.

The 79XX integrated also provide a fixed voltage output like the 78XX integrated circuits, but their difference is that 79XX series integrated circuits yield a negative (-) output. For example, the 7905 series integrated circuits provide a -5V fixed output voltage.

Those integrated circuits are 3 pin devices. The pins are IN (input), GND (chassis) and OUT (output) pins. The voltage applied to the Input pin is reduced to the XX value at the output. A voltage equal to at least to output voltage must be applied to the input of the integrated circuits.







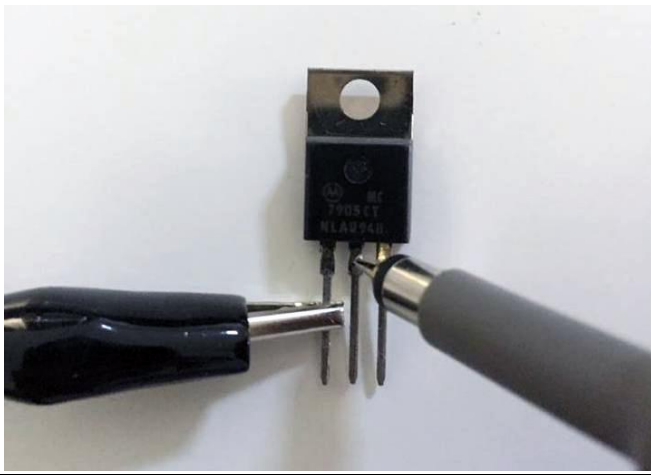


Figure 205 : 7909 Input VI Graph Channel1  
(Input) - COM (GND)

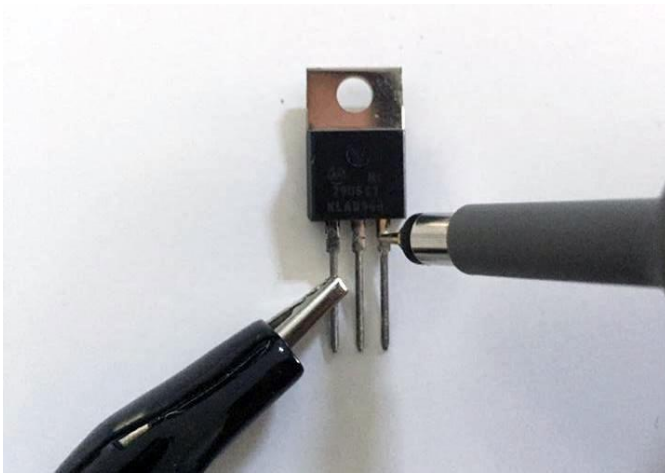
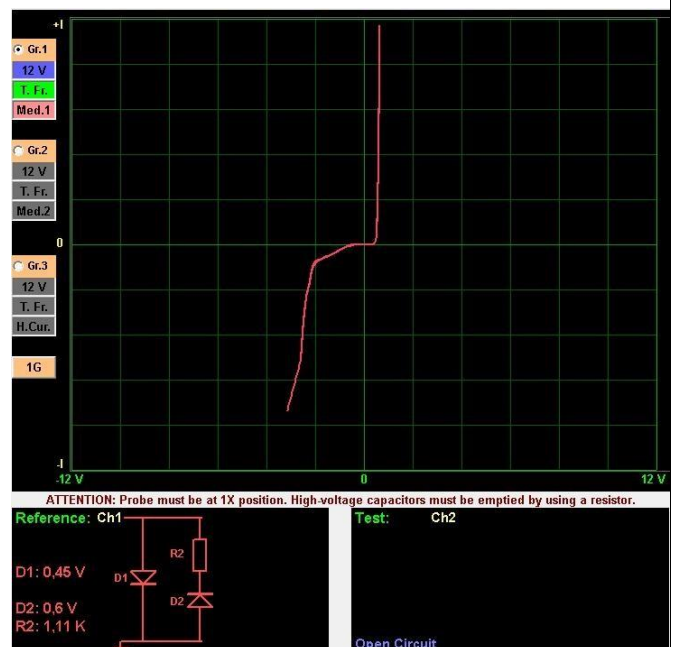
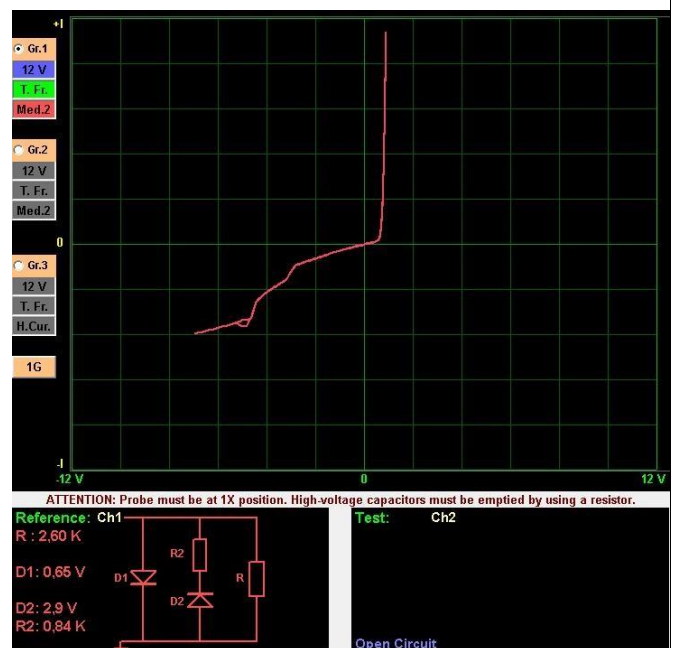


Figure 206: 7909 Output VI Graph Channel1  
(Output) - COM (GND)



## RECORDING THE ELECTRONIC CIRCUIT COMPONENTS TO THE MEMORY AND COMPARING FROM THE MEMORY

Another feature of the TESTIT FD20 Fault Detector and PC Oscilloscope is the ability to record (save) the data of the materials in the electronic circuit to the computer. The recording capacity is dependent on the hard disk capacity of the computer.

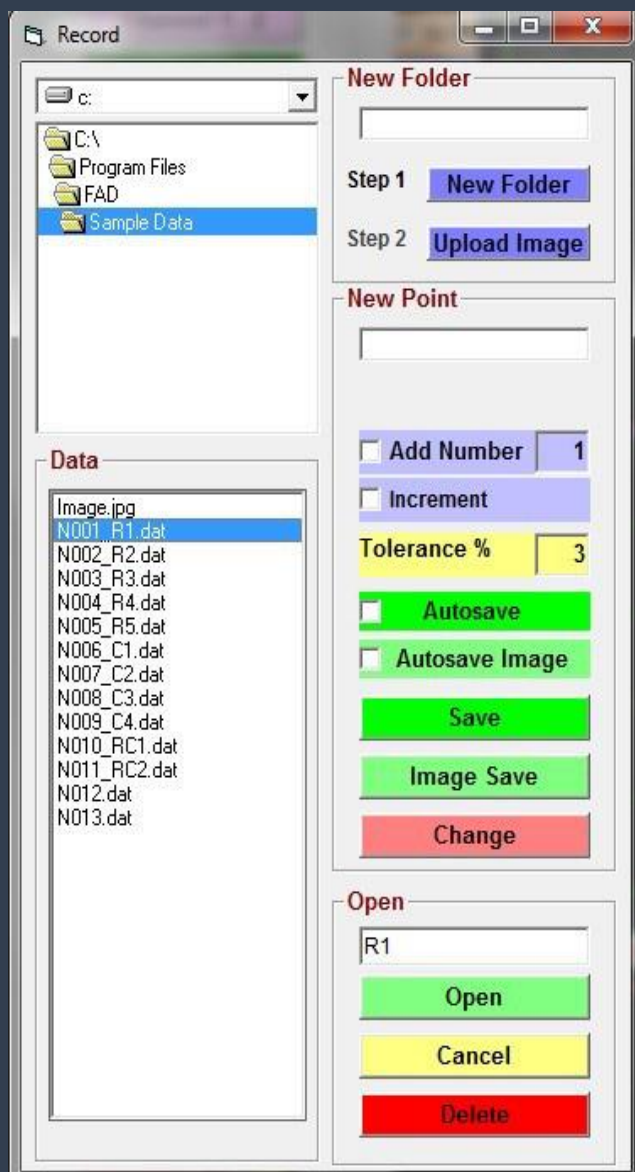


Figure 207: Recording Window

**New Folder:** New Folder opens a new folder on the hard disk with the name written to that line.

**Upload Image :** The software screen displays the circuit's photo saved in the computer.

**New Point:** The name of the data to be saved is entered. If left blank, the software adds a, "N001, N002 etc." file number to the file automatically.

**Add Number:** Adds a number to the file to be saved.

**Increment:** Increases the number of the data to be saved.

**Tolerance %:** Specifies the tolerance range of the data to be saved.

**AutoSave:** Channel 1 is connected to the pin or leg of the electronic material to be saved. The Software saves the data after a few seconds automatically and emits a sound confirming that the data were saved.

**AutoSave Image:** If the Auto save feature is selected, clicking on the save key saves the VI screen as a photograph automatically.

**Save:** Saves the graph of the test point (New point) data to the file designated (New Folder) with the name assigned.

**Image Save:** Saves the VI graph of the test point (New point) data to the file designated (New Folder) as a photograph with the name assigned.

**Change:** To change data of a test point saved previously, the graph of the test point saved is selected from "Data" and Channel1 is touched to the new test point to be saved and data of the test point saved previously is changed.

**Open:** Opens the saved test data selected from "Data".

**Delete:** Deletes the saved test data selected from "Data" from the computer.

**Cancel:** Closes the recording window.

**Data:** Displays the data saved.

## Recording the Electronic Components to the Memory

1. The Com Probe or Clip lead is connected to the chassis (GND) of the board (GND taken as reference).
2. The "Recording" Button is pressed to open the "Recording Window". The name of the folder to be saved in the "New Folder" is entered to create a new folder.
3. If a photo is to be recorded and a photo of the board is available in the computer, click on the "Image Upload" and select the photo of the electronic circuit board desired from the window opened. The photo is loaded to the software by clicking on the "Open" button. The photo of the circuit is opened at the lower right corner of the VI test screen. The Software changes the name of the photo as "image" automatically. For example; if the name of the photo is "Figure.jpg", the software changes the name to "image.jpg" automatically and saves to the folder as "image.jpg". It is displayed as "image.jpg" in the Recording Window Data. The green colored buttons in the photo are for the "+", "-" zooming function. The electronic material to be recorded in the board is selected by sliding the curser on the photo to the right or left. Thanks to that feature, when you make a comparison from the memory, you can see the location of the point recorded on the board.
4. The name of the point (data) to be recorded is written to the "New Point". Touch the Channel1 probe to the point to be recorded and consecutive recordings are made by pressing the record button. The data saved in the "Data" section are seen as N001 X vs. (the name or code of the data to be saved for the X New Point).  
If no name is entered for the "New Point", the software saves the data automatically in numerical order (N001, N002 etc.)
5. If "Add Number" is selected, the software adds a number to the data automatically and if the "Increment" is selected, increases the number added to the component by one after recording the component.  
For example, to save the VI graph of an IC component named "X", the "X" is entered in to the "New Point" field. "Add Number" and "Increment" are selected. The Channel1 is touched to the X component's pin in the electronic circuit and the VI graph appears on the screen. "Save" is clicked to save the data for the component "X".
6. Maximum 999 data points can be saved in a save folder.
7. We can record the components' graphs faster by selecting the "Autosave" feature.  
Channel1 is touched to the pin of the component to be recorded and after waiting for a few seconds, a "recorded" sound is emitted, confirming the automatic saving of the VI graph of the point.

**Note:** The user has to touch the component under test firmly after selecting "Autosave", since the graph of the component is saved only after a few seconds after the probe touches the component. If the user does not touch the component firmly, the software still continues to record, hence care should be exercised while using the "Autosave".

8. The Components' VI graphs may also be recorded using the print screen. To do that, after touching the Channel1 probe to the component's pin, click on the "Image Save" button to save the VI graph as a screen photo.
9. If "Autosaveimage" selected and the "Save" button is clicked, the VI graphs are recorded automatically as a photo and as data as well. The "Autosave" and "Autoimage" features can be used in coordination.

Changing the saved data; the data to be changed is selected from "Data". If a new name is to be assigned to the data, the code of the data is entered in to the new recording. Channel1 is touched to the point to be recorded and the "Change" button is clicked, thus changing the existing data. To erase any saved data, select the data to be deleted from "Data" and then click "Delete."

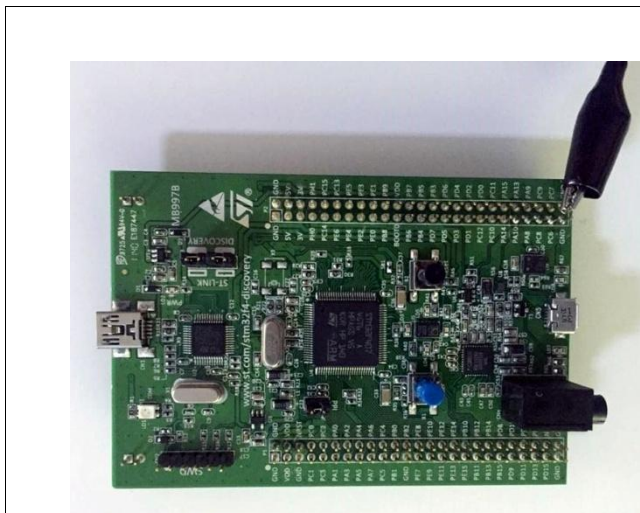


Figure 208: Connecting the Crocodile Probe Electronic Circuit Board Chassis (Step 1)

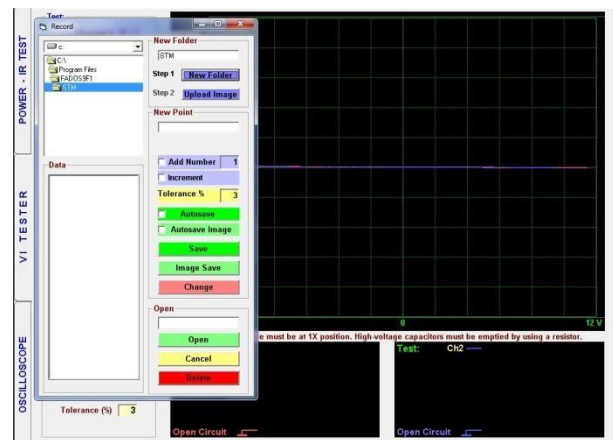


Figure 209: Clicking the Recording Button to Open the Record Window (Step 2)

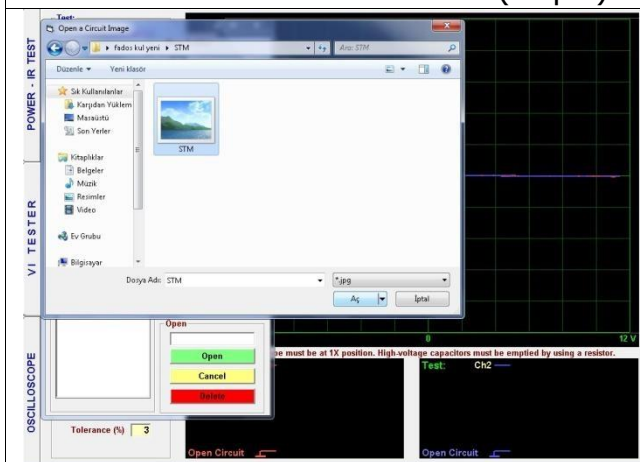


Figure 210: Loading the Photo of the Electronic Circuit to the TESTIT FD20 Software (Step 3)

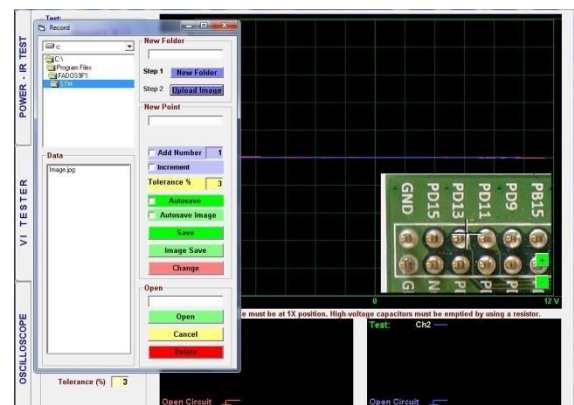


Figure 211: Loading the Photo of the Electronic Circuit to the Software (Step 4)



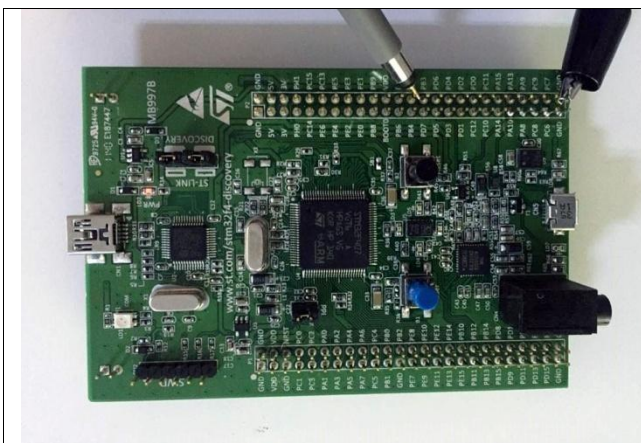


Figure 212: Touching the Channel1 Probe to the Component to be Recorded (Step 5)

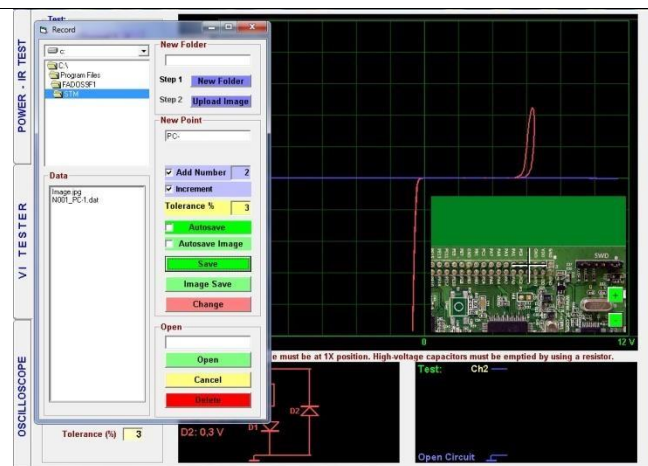


Figure 213: Saving the Electronic Circuit Component's VI Graph (Step 6)

## Comparing the Electronic Components from Memory

Click on the Recording Test selection in the TESTIT FD20 test characteristics menu to open the Recording Menu. Enter a circuit name or code to open a New Folder. The name of the point (data) to be saved is entered in to the "New Recording". Touch the Channel1 probe to the point to be recorded and consecutive recordings are made by pressing the record button. If no name is entered for the "New Point", the software saves the data automatically in numerical order (N001, N002 etc.). Maximum 999 data points can be saved in a save folder. If "Add Number" is selected, the software adds a number to the data automatically and if the "Increment" is selected, increases the number added to the component by one after recording the component.

1. The "Recording" button is clicked to open the recording window. The folder is saved with the New name is found. The data saved in "Data" is selected and opened by clicking the "Open" Button. The graph and data of the data saved is displayed on Channel 1. The number of data points is shown in the test area under the Memory Save Test menu and the pin to be tested is shown at the "Point" area.
2. If the recording is made with a photo, the photo of the electronic circuit board is shown in the lower right corner and the point to be tested can be seen in the photo.
3. The Com Probe or Clip lead is connected to the chassis (GND) of the board (GND taken as reference).
4. Channel 2 probe is touched to the point to be tested. If the point value measured is within the recorded tolerance range of the recorded data, a sound indicating conformity is emitted, and then the "Next Point" is clicked to open the second recorded data. If the value measured is not within the recorded tolerance range of the recorded data, a sound indicating non-conformity is emitted and the next point is not selected after lifting the probe. The "Arrow Button" on the right in the Recording Test Menu is clicked to go to the "Next Data".



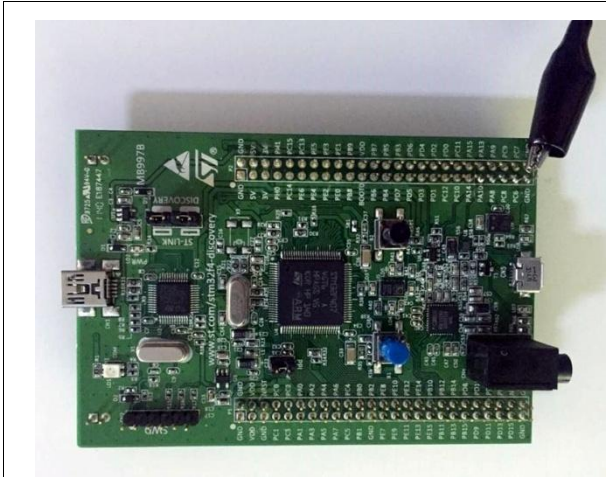


Figure 214: Connecting the Crocodile Probe Electronic Circuit Board Chassis (Step 1)

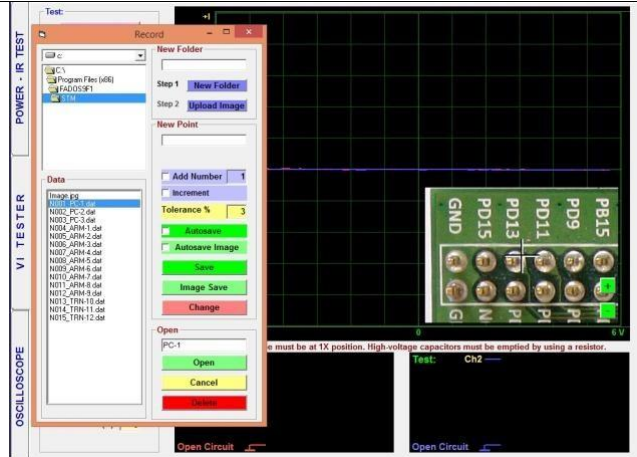


Figure 215: Clicking the Recording Button to open the Record Window (Step 2)

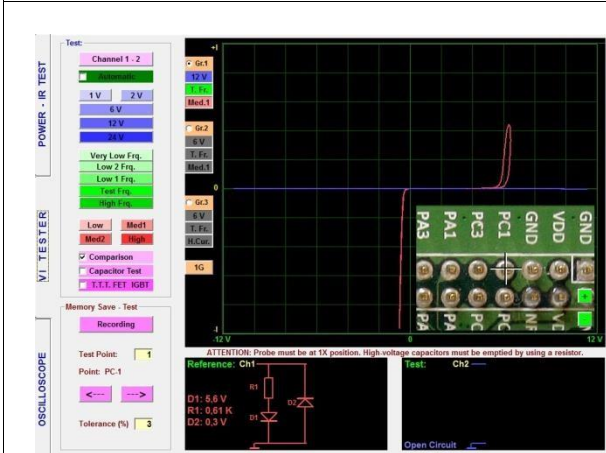


Figure 216: Opening the Recorded Data in the VI Screen (Step 3)

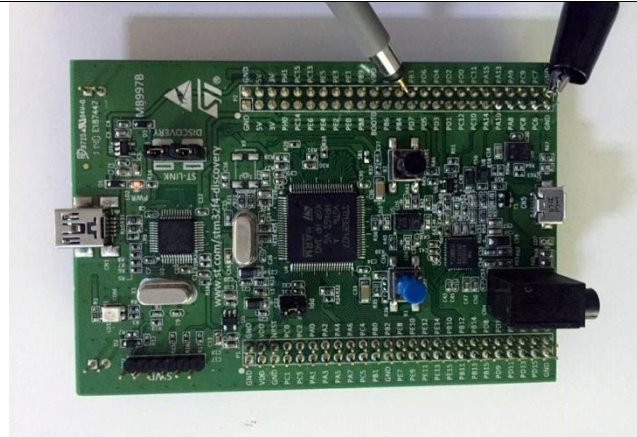


Figure 217: Touching the Channel2 Probe to the Component to be Tested (Step 4)

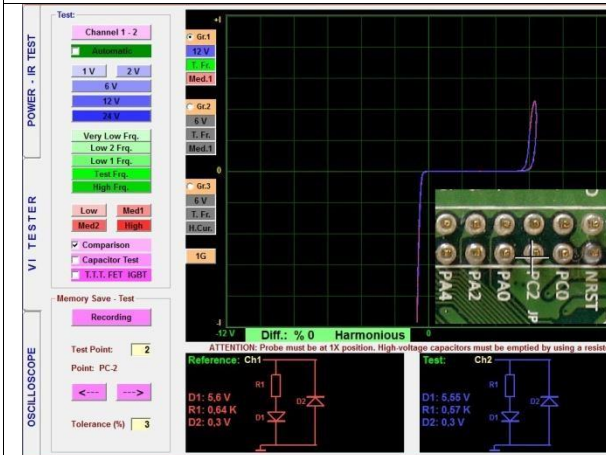


Figure 218: Memory Comparison of Intact Component (Step 5)

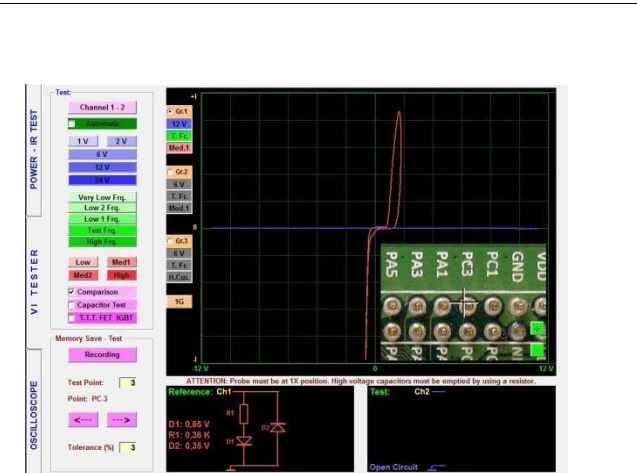


Figure 219: If the Data Measured is Recorded and Conformant; the Next Data is Opened Automatically

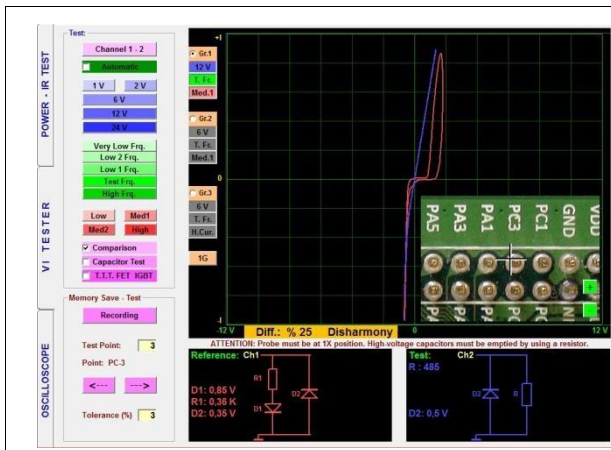


Figure 220: Memory Comparison (Defective Component)

The device emits different sounds for the compatible and un-compatible graphs. This feature allows testing rapidly without looking at the screen constantly.

**Note:** The test points in the Electronic circuits can be recorded with Channel 1 only. We can open the test points recorded using the Recording menu as reference in Channel 1 and make the comparison tests for the defective circuit points with Channel 2.

## Image Save

The screen shots of the VI graphs may also be recorded using the print screen. As below, the "Save" button is clicked for recording the electronic component data to the memory for the "Electronic Components Memory Recording". If we want to record the screen shots only, the "Image Save" button is clicked instead of the "Save" button.

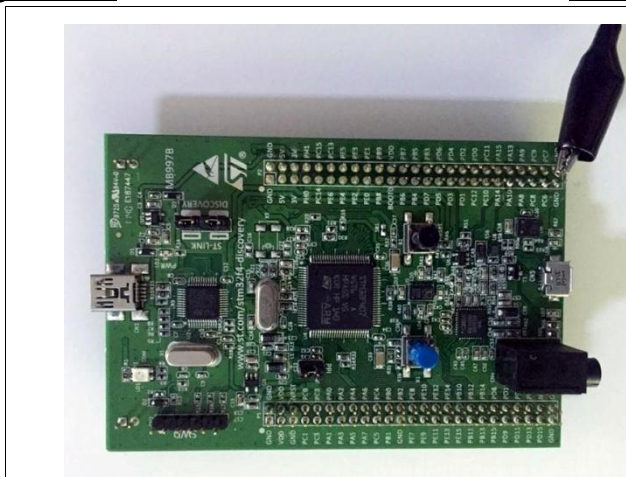


Figure 221: Connecting the Com Probe Electronic Circuit Board Chassis (Step 1)

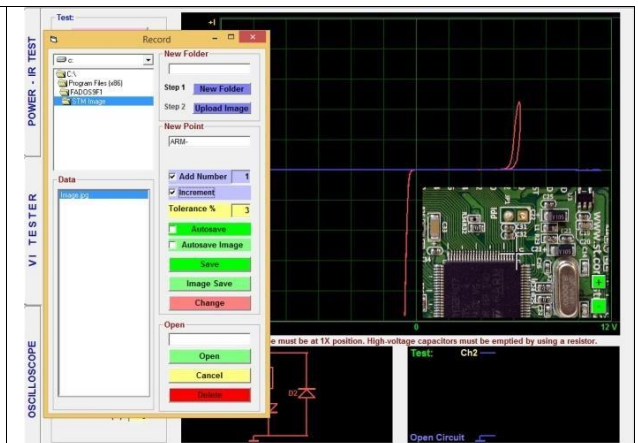


Figure 222: Touching the Channel1 Probe to the Component to be Recorded (Step 2)

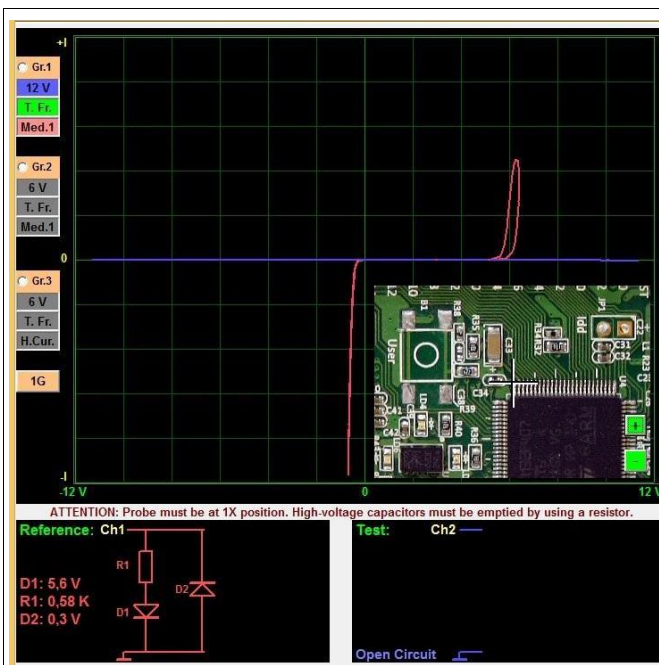


Figure 223: Clicking the ImageSave Button (Step 3)

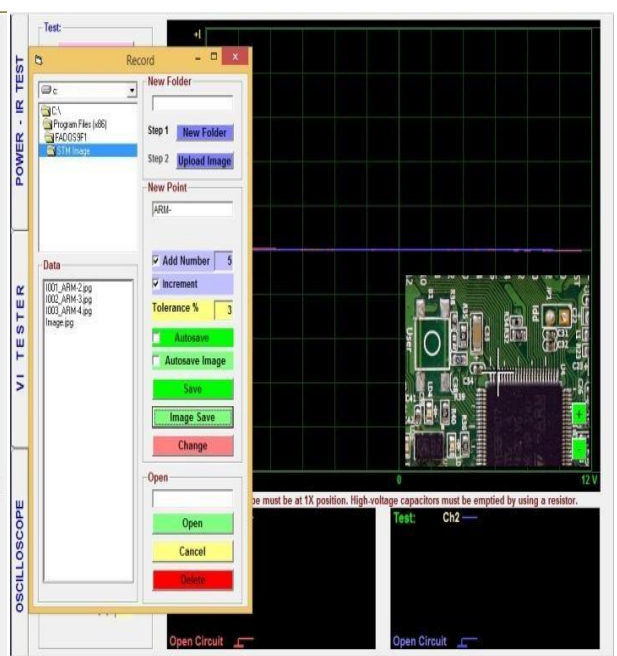


Figure 224: Recording the VI Graphs as Photos

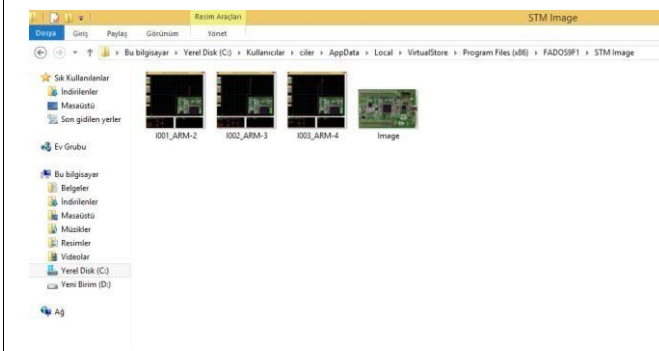


Figure 225: Displaying the Recorded VI Photos in the Folder Created

**Note:** When the "Image Save" button is clicked, the data is recorded as "I001 .jpg". VI graphs are saved as "N001 .dat". In order not to confuse the recorded data, saving the VI graphs and Image Save data in different folders is recommended.

**Note:** The Windows operating systems saves the recorded data in the "**Virtual Store**" folder. The "**Virtual Store**" folder can be found in;

C:\Users\\*(Computer Name)\AppData\Local\VirtualStore\Program Files (x86)\TESTIT FD20\

## COMPARATIVE TEST OF THE MATERIALS IN THE ELECTRONIC CIRCUITS

When an electronic material is tested in the circuit, it produces a mixed signal due to the parallel or series connections to the other materials in the circuit. If you have enough experience in Analog Signal Analysis, (of the VI graphs), the failure can be found by interpreting the graphs. The aim of Electronic circuit board repairs is diagnosing the failure without removing the components on the board.

Comparing the VI graphs of the intact and defective electronic circuit boards determined with the TESTIT FD20 allows diagnosing the defective materials in a short time. The comparison is made by touching the pins of the materials on both electronic circuit boards to find the difference between them.

While comparing two electronic circuit boards, the following points should be observed:

- 1)** The electronic circuit boards to be tested should not be energized. Since the capacitors are energy storing devices, they should be discharged (especially high voltage capacitors).
- 2)** The Electronic cards must be identical (version etc.)
- 3)** Connect the COM probe (or crocodile of probe) to the common chassis (GND) of the Electronic circuit board. The GND point can be found by following the GND (Vss) pin of the IC or the anode pin of the electrolytic capacitors. If a low capacitive graph is observed at the points tested, it means that the GND point is not right. Some electronic circuit boards may have more than one GND points. The reason for that is the presence of components operating on different voltage values in the board. In order to eliminate the capacitive noise, the supply and GND may be shorted. This will offer the advantage of comparing the VI curves both according to the GND and the Vcc pin.
- 4)** While comparing, first the circuit board supply (the integrated regulator) is tested. If the supply of the circuit board is defective, the same failure will appear in all the other electronic components in the circuit.

The input and output connectors on the circuit board are compared and if any difference is found, the path from the connector can be traced to the defective component.

One feature of the TESTIT FD20 is that the software emits different sounds for matching and un-matching graphs. The comparison can be made rapidly by focusing on the sounds without looking at the display constantly.

- 5)** To diagnose the defective component in the area showing the difference, the COM probe is connected to the deviant point. The components connected to that point are compared, whereby the defective material is identified without removing from the circuit. The suspect material may also be tested after removing from the circuit if desired.
- 6)** After replacing the defective component identified, the comparison test is repeated on the circuit boards.

If an intact board is not available, the defective cards may be compared against each other to diagnose the defective material. Sometimes a fault may not be present in another board. Therefore, the most suspect components are checked first to diagnose the failure.



The VI graphs of the Electronic materials are different from each other. With adequate experience on the VI graphs a defective component on a single defective board can also be diagnosed. If there may be symmetrical circuits on a board, they may be compared against each other. The integrated circuits in the circuit may be diagnosed by checking the datasheets and then testing the pins with the same functions (input – output pins) respectively. Because the IC pins have protective diodes, the diode or Zener diode curves should be observed. If there are any short circuits, open circuits or irregular resistor or diode shown in the zener curves, then the integrated circuit is defective. If necessary, the IC can be removed from the circuit and the pins tested after shorting the GND and Vcc pins.

The transistor, FET, IGBT, Thyristor etc. 3-pin devices may be tested by checking if they are conducting.

Recording the data to the memory after repairing the Defective circuit is recommended.

While making a comparison with the TESTIT FD20 device, the chassis of the intact board is connected to Channel 1 and suspect board to Channel 2. Start comparing from the power supply lines and progress towards the inputs and outputs and any other places suspected. The comparison can be made rapidly by focusing on the sounds without looking at the display. First the supply circuit of the electronic circuit board (the regulator) is checked, if the regulator circuit is defective, the signals from all the components may show differences while comparing. The other components are tested after eliminating the regulator circuit failure.

Sometimes an un-matching sound may be heard due to the charging and discharging of some capacitors, but the graph curve will eventually become compatible once the capacitor is charged after waiting for a short while.

Because the tolerance range of the Capacitors is quite large, some small mismatches may be seen in the VI graphs while comparing. When the graph is examined closely, the source of the mismatch will be identified as the capacitor's tolerance. The Vcc and GND are shorted to prevent the capacitors in the Supply circuit from charging.



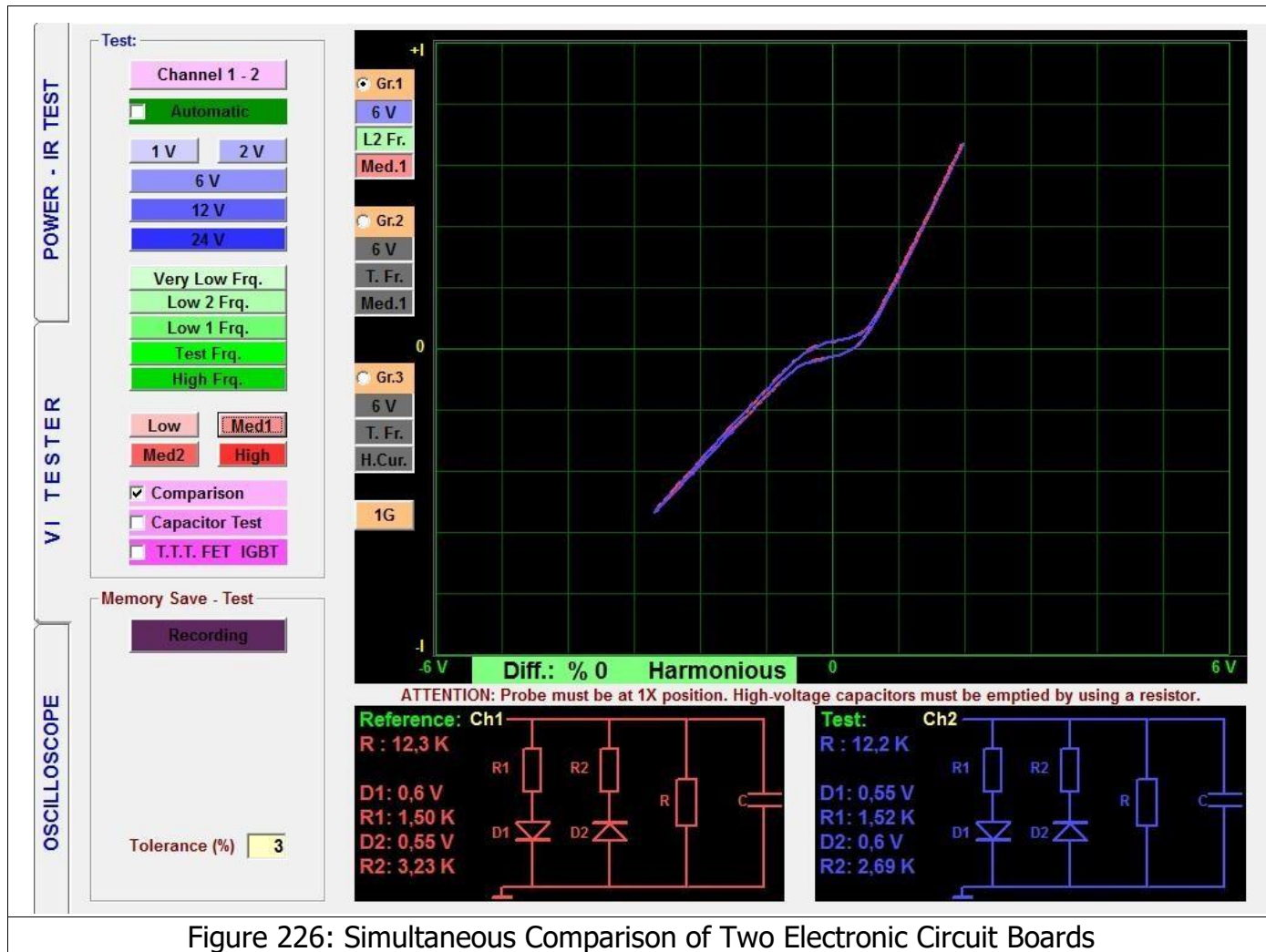


Figure 226: Simultaneous Comparison of Two Electronic Circuit Boards

A very accurate comparison can be made with this system and the values that remain within the given tolerances are considered as compatible. However, interpreting the small differences as defects or not depends on the experience of the user.

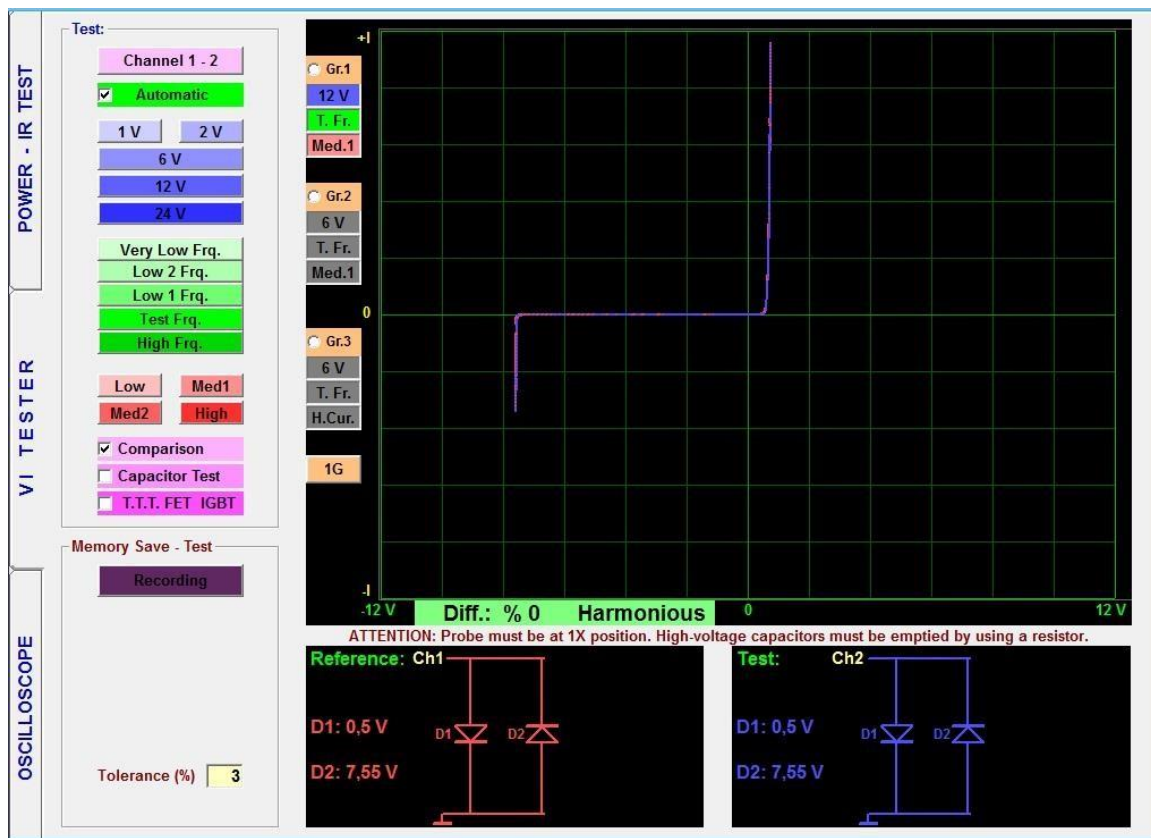


Figure 227: Comparing the Transistor Base Areas (Intact Component)

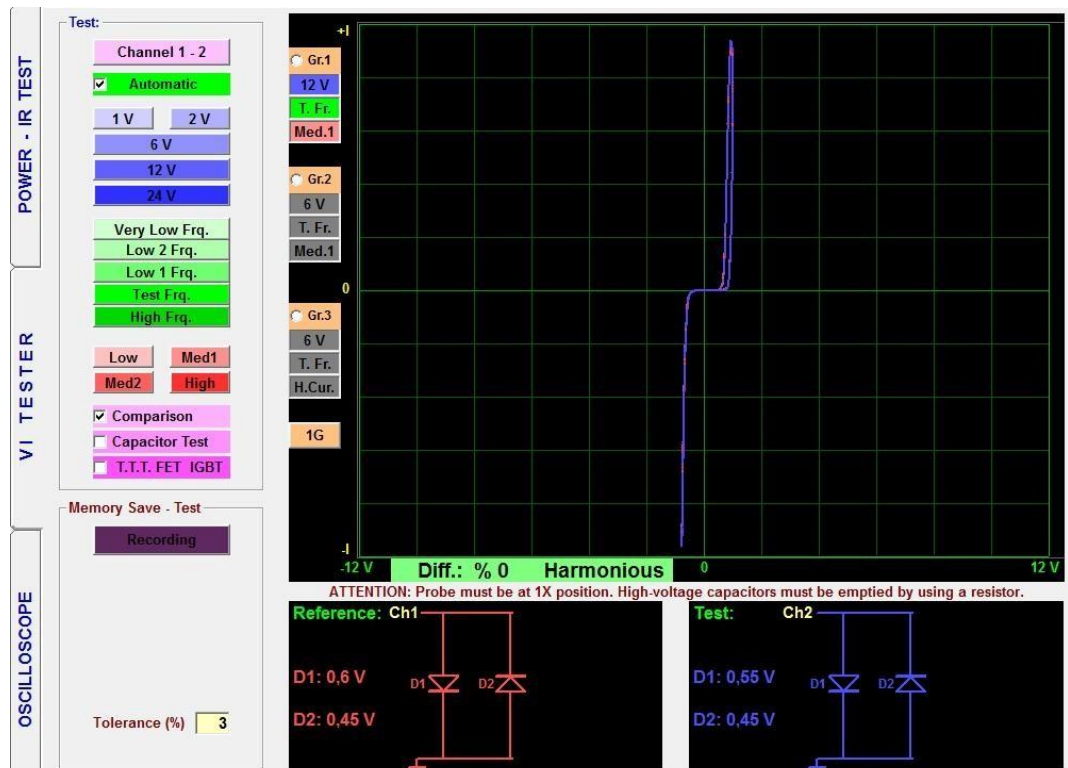


Figure 228: Comparative Test

The Integrated circuits generally contain dual reverse diodes. Capacitors or resistor may be connected to these diodes. If an Integrated circuit pin has a dual reverse diode, that pin of the integrated circuit may be considered as intact. If a perfect match is found, this point should be intact.

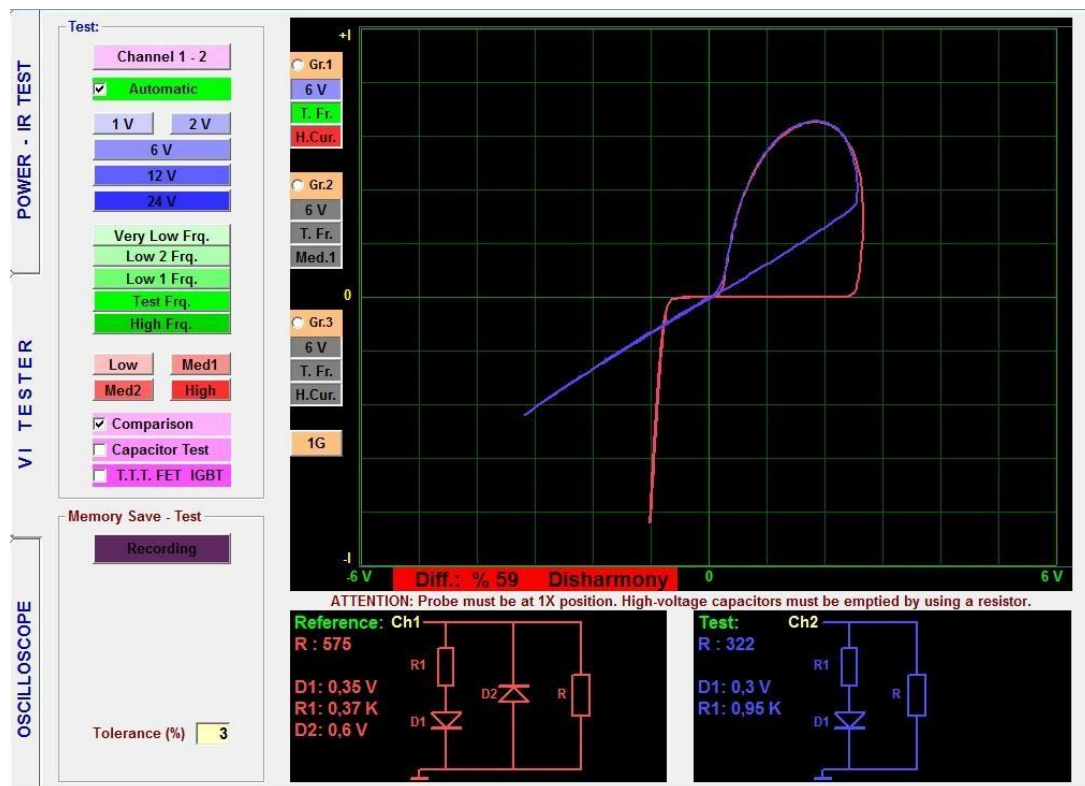


Figure 229: Comparative Test - Defective IC (Channel2)

The important difference to pay attention in Figure 229 is the presence of an open circuit in a limiter diode of the when tested with Channel2.

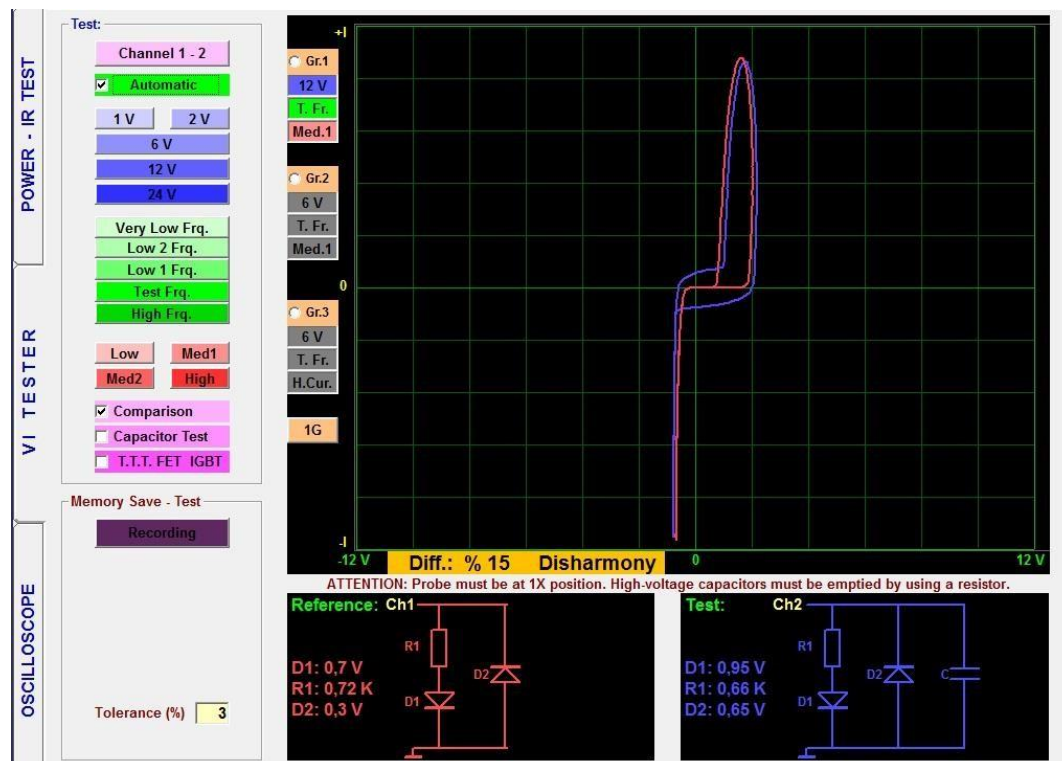


Figure 230: Comparative Test - IC Intact - Capacitor Open Circuit

The important difference to pay attention in Figure 230 is the presence of an open circuit in a capacitor of the when tested with Channel 1. In this case, the Integrated circuit is intact but the capacitor is defective.

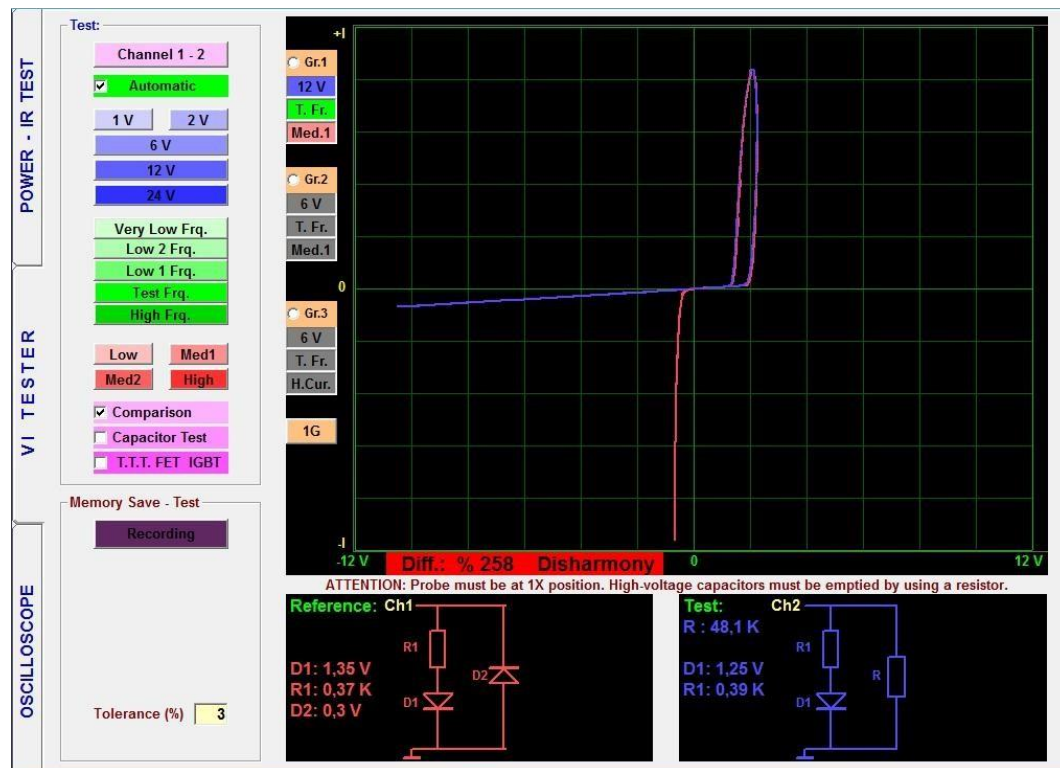


Figure 231: Comparative Test - Faulty IC (Channel2)

The important difference to pay attention in Figure 231 is the presence of a defective limiter diode in the IC acting as a when tested with Channel 2.

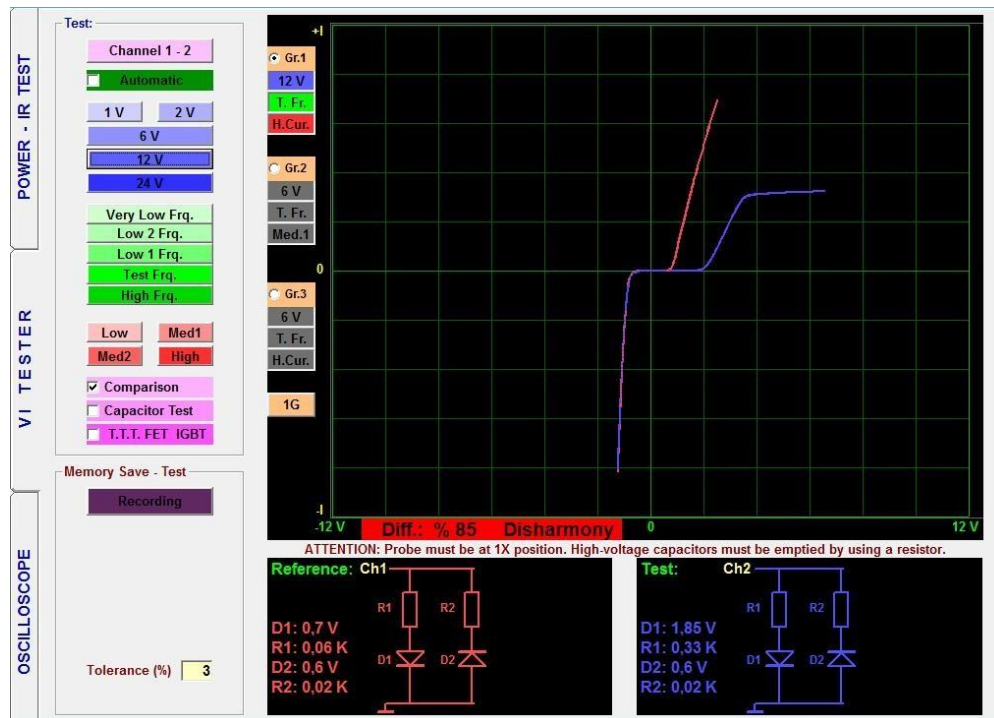


Figure 232: Comparative Test - Faulty IC (Channel2)

In the example given in Figure 232, a damaged Zener diode due to a destroyed IC pin tested with Channel 2 is illustrated.



### 3G – DISPLAY OF THE GRAPHS FOR 3 DIFFERENT SETTINGS

The TESTIT FD20 can make comparisons on the electronic circuit boards at 3 different settings simultaneously.

By clicking the 1G button, the failure diagnostics screen is switched to 2G, that is the Gr.1 and Gr.2 active graph. In 3G the Gr.1, Gr.2 and Gr.3 can be displayed by selecting different voltage, frequency and current stages.

Using this method, the response of the electronic component against different voltage, frequency and current stages can be observed. E.g. while some electronic material's graph may appear intact under low current, it may prove to be defective under high current.

For example, in Figure 233; click the 1G button once to select 2G, i.e. VI screen 2 graph setting.

Click on Gr.1 to select the Voltage stage 6V and set the Frequency stage to Test Frequency, and Current stage to Low Current. Click on Gr.2 to select Voltage stage 6V and set the Frequency stage to Test Frequency, and Current stage to High Current. In that case, the Voltage and Frequency stages are same, but the current stage is different. As seen on the screen, 2 graphs will appear. If the comparison feature is selected, the 2 electronic circuit boards may be compared at two different settings.

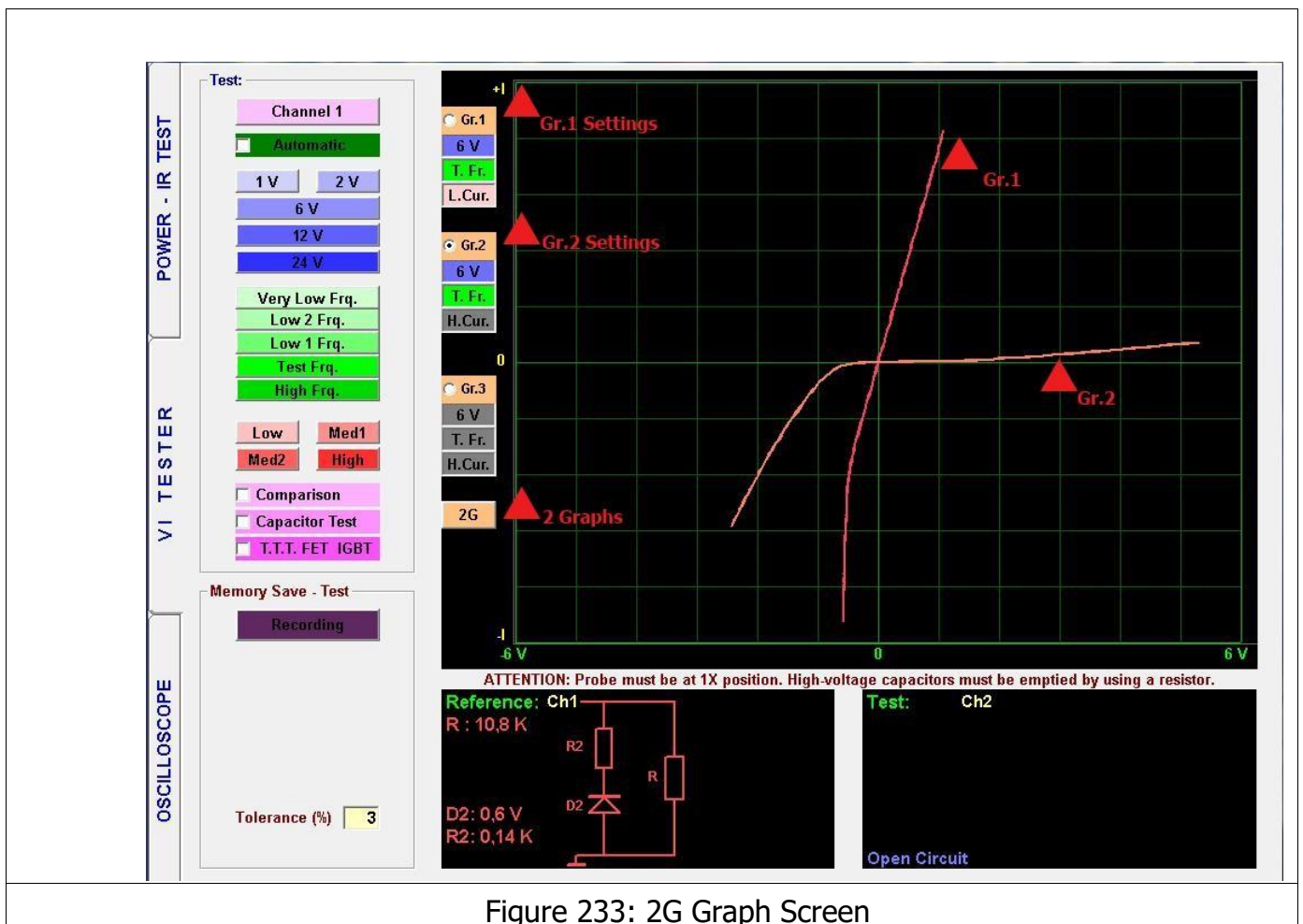


Figure 233: 2G Graph Screen



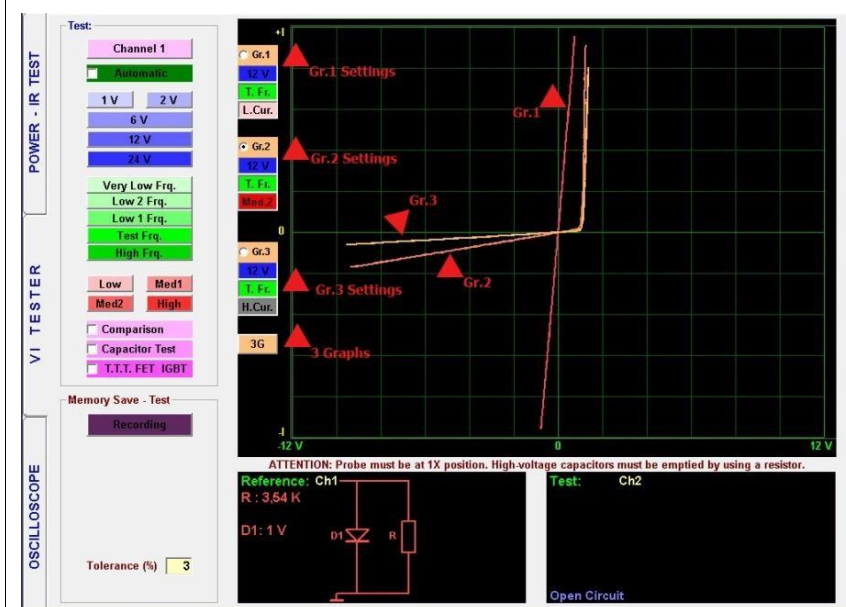


Figure 234: 3G Graph Screen

For example in Figure 234; click the 1G button twice to select 3G, i.e. VI screen 3 graph setting. Click on Gr.1 to select the Voltage stage 12V and set the Frequency stage to Test Frequency, and Current stage to Low Current. Click on Gr.2 to select Voltage stage 12V and set the Frequency stage to Test Frequency, Current stage to Medium Current. Click on Gr.3 to select Voltage stage to 12V and set the Frequency stage to Test Frequency, Current stage to High Current. In that case, the Voltage and Frequency stages are same, but the current stage is different. As seen on the screen, 3 graphs will appear. If the comparison feature is selected, the 2 electronic circuit boards may be compared at three different settings.

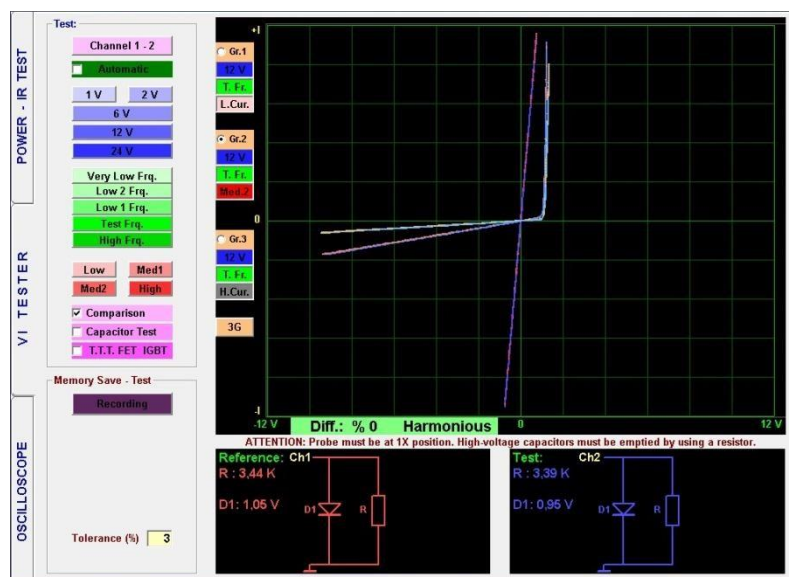


Figure 235: 3G Comparison

In Figure 235, comparison of the 3 graphs at 3 different settings and a perfect match at different settings is shown.

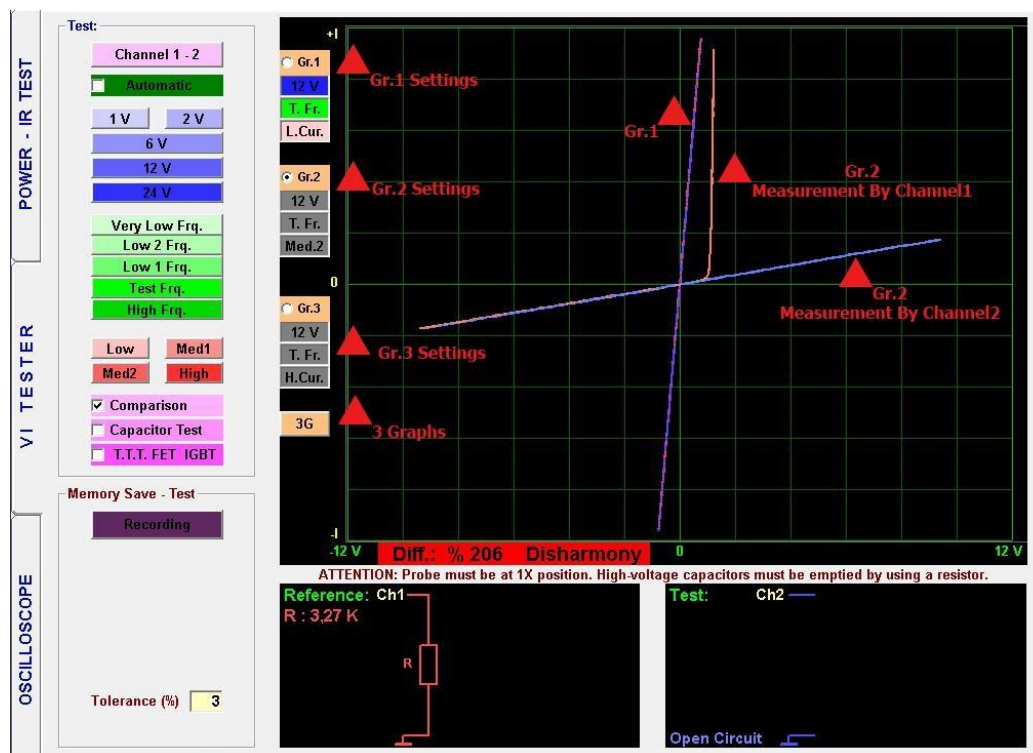


Figure 236: 3G Comparison

Figure 236 shows comparison of 3 graphs at 3 different settings. As seen in the example, the material, which shows a perfect match at low current, shows a mismatch at Medium2 current. Therefore, the electronic material tested is defective.

**Note:** High Frequency stage uses at only 6 Voltage stage and you should not use High Frequency at 3G features.

## OSCILLOSCOPE – PROGRAM CHARACTERISTICS

As a device with the widest measurement capabilities used for measuring and evaluating the electrical signals, the oscilloscope allows determining the wave form, frequency and amplitude of the signal. The Wave form is displayed on the screen. It draws an electrical wave signal, allowing observation the frequency and amplitude of the Wave Signal. The oscilloscope is a supplemental feature of the TESTIT FD20; therefore, the maximum measurement frequency is 400 KHz and the measurement voltage is 50 V when the probe is set to 10X.

The TESTIT FD20 may also be used as a Square Wave Generator and Analog Voltage Output. The Square Wave Signal Output applies a signal to the electronic circuit board and the other channels display the output signals on the oscilloscope screen.

All the control keys used for the Oscilloscope screen are placed at the left side of the panel.

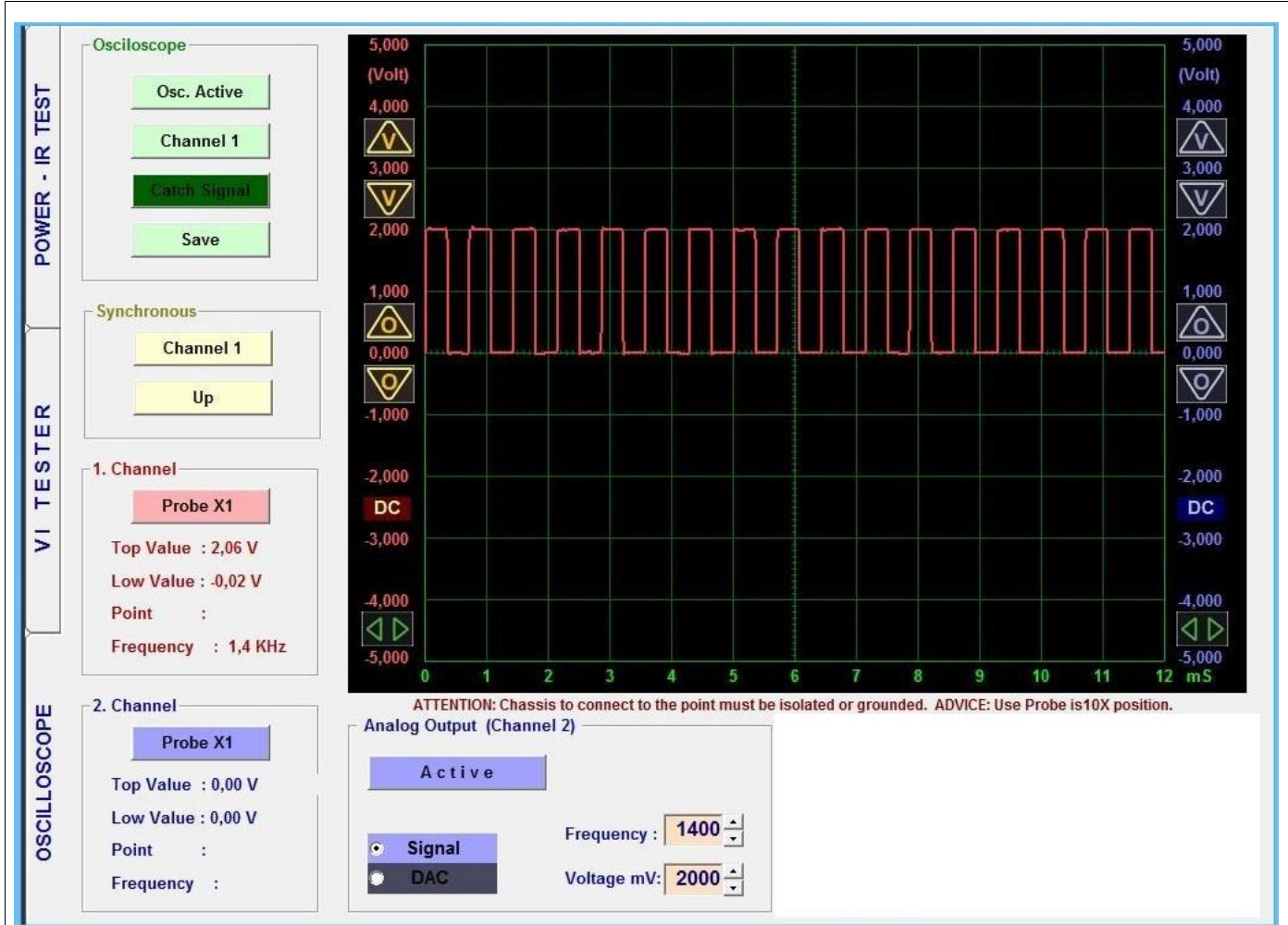


Figure 237: Oscilloscope Screen

**Oscilloscope**

Osc. Active

Channel 1 - 2

Catch Signal

Save

**Synchronous**

Channel 1

Up

**1. Channel**

Probe X1

Top Value : 0,04 V

Low Value : -0,03 V

Point :

Frequency :

**2. Channel**

Probe X1

Top Value : 0,02 V

Low Value : -0,03 V

Point :

Frequency :

**Osc. Active/Passive:** The Oscilloscope button activates the oscilloscope or freezes the current image and records the image to the memory when the recording button is clicked.

**Channel:** Channel1, Channel2 and both channels are selected consecutively.

**Manual/Auto:** When the Manual mode is selected, the signal is captured within the lower limit (mV) and upper limit (mV) values. In the Automatic mode, the last signal is captured when the signal ends.

**Save:** Records the Oscilloscope data or opens the recorded data.

**Channel1:** Selects the channel with the starting synchronization.

**Up/Down:** Starts synchronizing from the rising or falling edge.

**Probe X1:** Sets the voltage value according to the Probe X1 or X10 factor. If the Probes are set to the 10X stage and X1 is clicked from the software to set the Probe at the 10X stage.

**Top and Low Values:** These are the largest and smallest values in the section displayed.

**Point:** Shows the voltage value at the vertical line of the curser in the memory mode.

**Frequency:** Shows the frequency if the incoming signal can be detected.

**Analog Output (Channel 2)**

Passive

Signal

DAC

Frequency : 1000





Voltage mV: 1000

**Active/Passive:** When this button is clicked, Channel2 generates a "Square Wave" or "Analog Output".

**Signal/DAC:** Selects Square Wave or Analog Voltage.

**Frequency:** Determines the frequency of the Square Wave Signal Output.

**Voltage mV:** Determines the voltage of the Square Wave or Analog Output.

	<b>Voltage Display Sensitivity:</b> Adjusts the Voltage display sensitivity. The data received from the product does not change the sensitivity. Pressed once or continuously. The figures show the voltage values. If the figures are dual clicked, the "0 V" reference for the associated channel starts at the point clicked.		
	<b>Zero Adjustment:</b> Shifts the location of the "0 V" of the image up or down. The figures show the voltage values. If the figures are double clicked, the "0 V" reference for the associated channel starts at the point clicked.		
	<b>Starting Adjustment:</b> Set the starting location of the section of the data to be displayed in 'Memory' mode.		<b>Speed Adjustment:</b> This is the Time/Division setting. The Horizontal axis (time axis) sets the time per square.

The Dual Channel Oscilloscope may also be used as a Square Wave Generator and Analog Voltage Output. The Square Wave Signal Output applies a signal to the electronic circuit board and the other channels display the output signals on the oscilloscope screen.

While measuring a signal with the Oscilloscope, using the Probe at the 10X stage is recommended. The chassis must be isolated or grounded. The Com Probe is connected to the chassis of the board. The Probes are set to the 10X stage and X1 is clicked from the software to set the Probe at the 10X stage. Then the probe is touched to the material to be tested and the material's voltage and frequency are measured.

**Note:** Please use the probe at 10X stage for the signal measurements above 5 V.



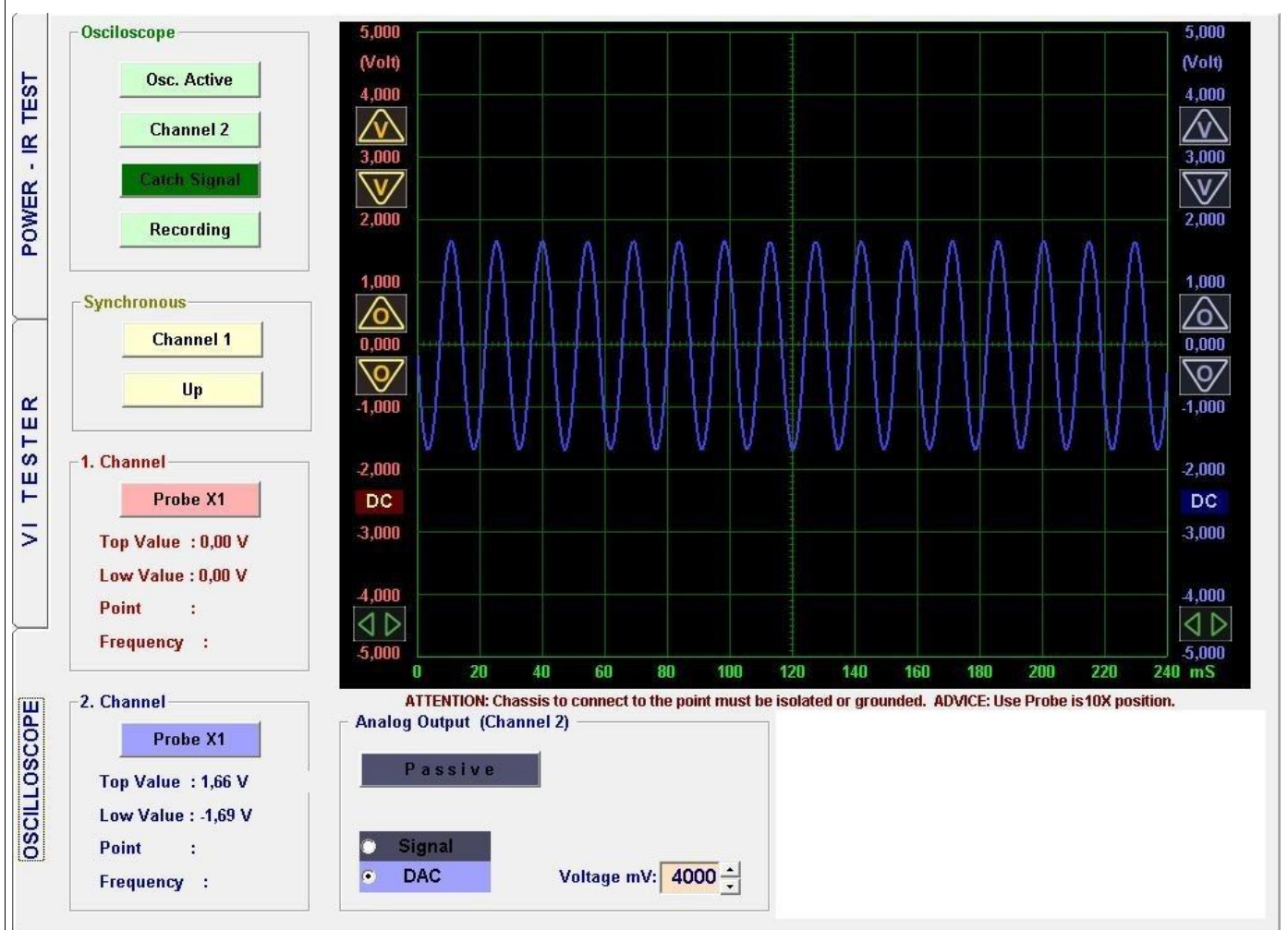


Figure 238: Oscilloscope Screen

## DAC - Square Wave Generator

The TESTIT FD20 may also be used as a Square Wave Generator and Analog Voltage Output. The Square Wave Signal Output applies a signal to the electronic circuit board and the other channels display the output signals on the oscilloscope screen. Channel 2 Probe is used for Analog Voltage Output or Square Wave Signal output.

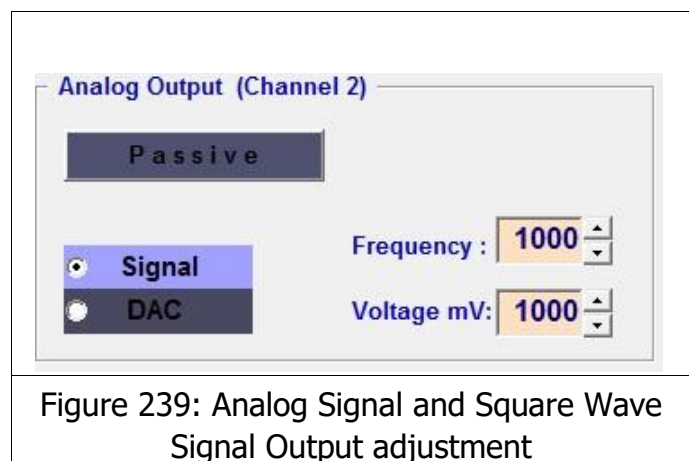


Figure 239: Analog Signal and Square Wave Signal Output adjustment

Figure 239 shows the Analog Signal and Square Wave Signal Output adjustment. For example; if we want to obtain a Square Wave Signal output, the signal is selected, the frequency of the is selected from Frequency and the voltage is selected from the Voltage setting. The Passive button is clicked for activating. The Channel 2 probe generates the Square Wave Signal Output we can measure the signal generated by touching the Channel 1 probe to the Channel 2 probe.

Figure 240 shows the measurement of the square wave signal generated by Channel 2 using Channel 1.

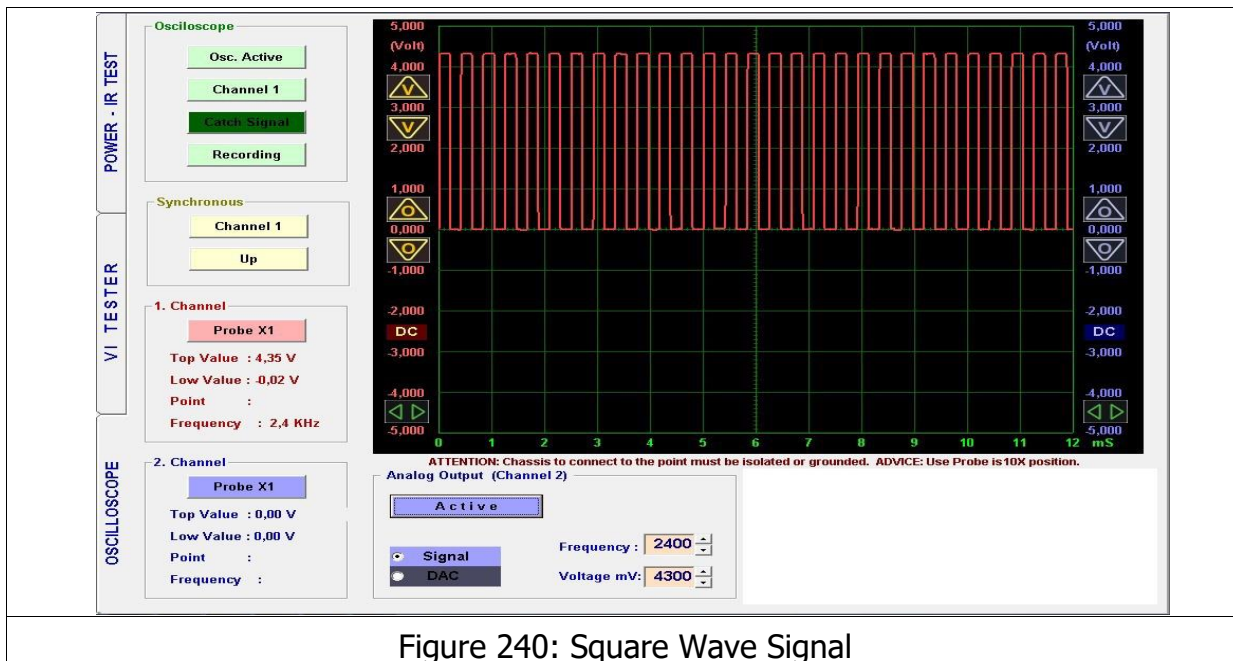


Figure 240: Square Wave Signal

For example, if we want a digital output of an Analog signal, the DAC is selected. The voltage of the signal is adjusted from Voltage mV. The Passive button is clicked for activating; Channel 2 generates an output. We can measure the signal generated by touching the Channel 1 probe to the Channel 2 probe.

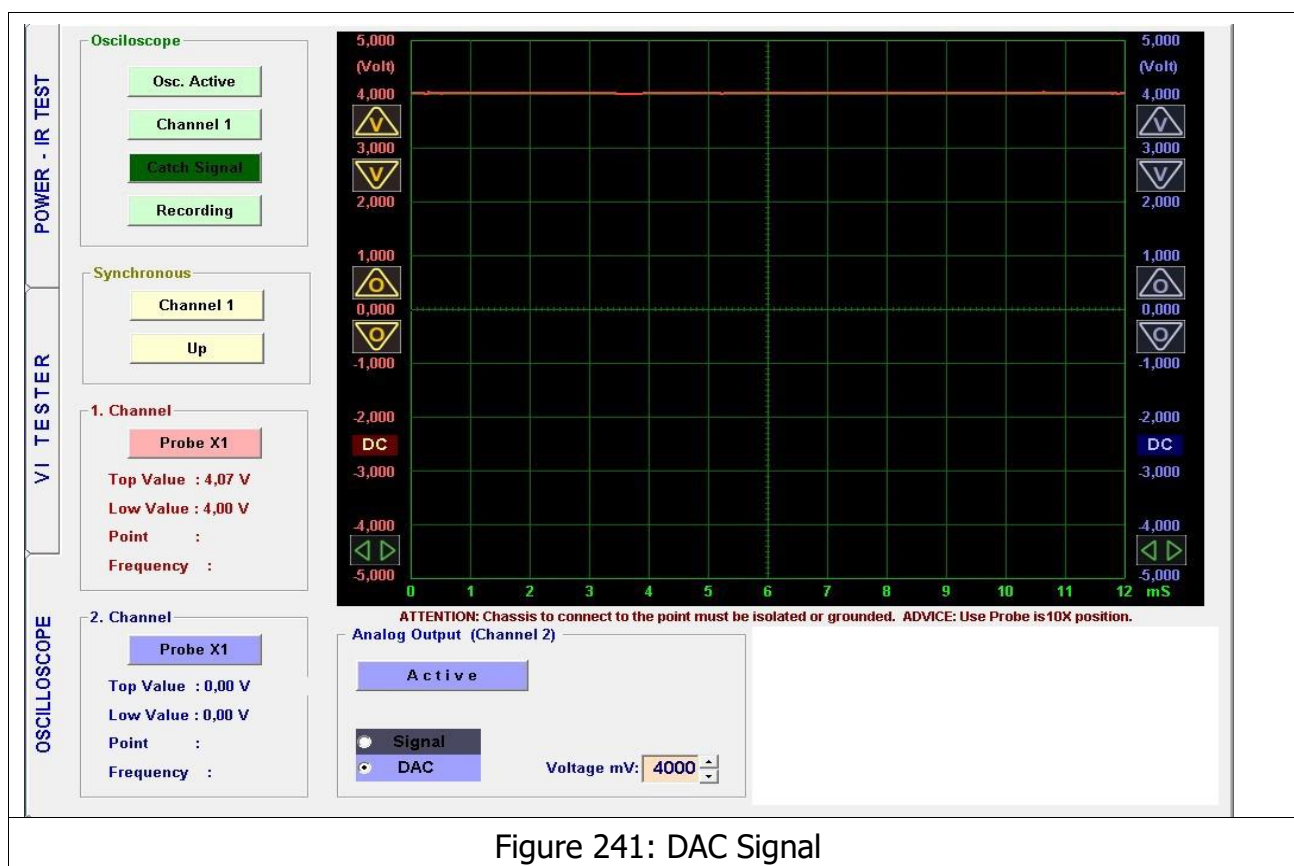


Figure 241: DAC Signal

## ISSUES TO KEEP IN MIND - RECOMMENDATIONS

1. The probes have to be at the 1X setting for troubleshooting (fault detection).
2. The key point in troubleshooting is the perfect matching of the graphs. The equivalent circuit diagram and values at the bottom are reference tools. The values shown in the circuit are for comparison purposes only and not for measurement. Wrong indications are possible due to the effects of other components on the board.
3. Use the medium current stage for general troubleshooting. Select the low current stage only where necessary (ex. High value resistor or low value capacitor).
4. The 1X position of the probe in the Oscilloscope mode measures up to 5V, and the 10X setting up to 50 volts. Measuring High voltage circuits is not recommended.
5. The calibration setting of each product is different and the calibration file can be found in the program installation folder. Please do not lose the Program Flash Drive.

## ERROR CODES

- 1) Run - Time Error '339':** Some other programs in the computer may use some common files with the TESTIT FD20 software. If we delete any program from the computer, the file used by TESTIT FD20 may also be deleted. When the above error is displayed, it means that the 'COMDLG32.OCX' file was deleted. If you uninstall and re-install the TESTIT FD20 software to the computer, the 'COMDLG32.OCX' file will be reloaded as well.

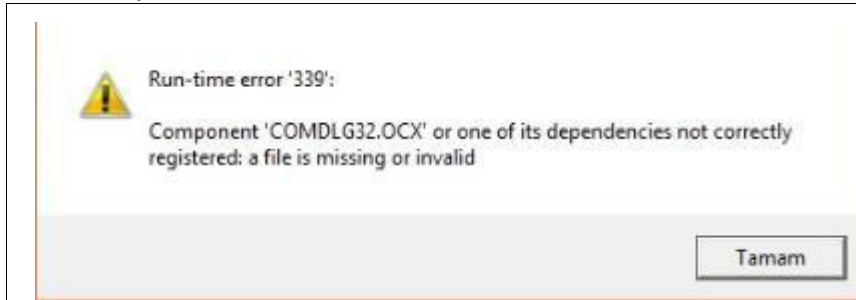


Figure 242: COMDLG32.OCX

- 2) Run - Time Error '6':** When you record the Electronic materials' data with their photos, if the resolution and dimensions are too high for the software the error will be displayed. Please reduce the resolution of the photo.



Figure 243: Overflow

## CONDITIONS OF WARRANTY

- 1.** The warranty period is 1 year (12 months) starting from the delivery date of the product.
- 2.** The repair period is seven (7) business days.
- 3.** Any malfunctions arising out of using the product in violation of the issues specified in the user manual are excluded from the warranty. If higher voltages than those specified for the device are applied to the probes, the series resistors connected to the probes inside the device will burn out. Burn out of resistors will indicate a user error such as not discharging a high voltage capacitor. Such conditions are excluded from the warranty coverage.

- 4.** The device is placed in an aluminum casing which protects the electronic circuit board against any damage. Breaking the case or the electronic circuit board, water damage etc. are excluded from the warranty coverage.
- 5.** The probes may be damaged during use; probe failures are not covered by the warranty.
- 6.** In case of a device failure, please send the product to WESTKONE OY/AB or contact our authorized distributor without trying any operation on the product.

**WESTKONE OY/AB**

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