Thyristor and Rectifier Testing Using Curve Tracers

Introduction

One of the most useful and versatile instruments for testing semiconductor devices is the curve tracer (CT). Tektronix is the best known manufacturer of curve tracers and produces four basic models: 575, 576, 577 and 370. These instruments are specially adapted CRT display screens with associated electronics such as power supplies, amplifiers, and variable input and output functions that allow the user to display the operating characteristics of a device in an easy-to-read, standard graph form. Operation of Tektronix CTs is simple and straightforward and easily taught to non-technical personnel. Although widely used by semiconductor manufacturers for design and analytical work, the device consumer will find many uses for the curve tracer, such as incoming quality control, failure analysis, and supplier comparison. Curve tracers may be easily adapted for go-no go production testing. Tektronix also supplies optional accessories for specific applications along with other useful hardware.

Tektronix Equipment

Although Tektronix no longer produces curve tracer model 575, many of the units are still operating in the field, and it is still an extremely useful instrument. The 576, 577 and 370 are current curve tracer models and are more streamlined in their appearance and operation. The 577 is a less elaborate version of the 576, yet retains all necessary test functions.

The following basic functions are common to all curve tracers:

- **Power supply** supplies positive DC voltage, negative DC voltage, or AC voltage to bias the device. Available power is varied by limiting resistors.
- **Step generator** supplies current or voltage in precise steps to control the electrode of the device. The number, polarity, and frequency of steps are selectable.
- **Horizontal amplifier** displays power supply voltage as applied to the device. Scale calibration is selectable.
- **Vertical amplifier** displays current drawn from the supply by the device. Scale calibration is selectable.

Curve tracer controls for beam position, calibration, pulse operation, and other functions vary from model to model. The basic theory of operation is that for each curve one terminal is driven with a constant voltage or current and the other one is swept with a half sinewave of voltage. The driving voltage is stepped through several values, and a different trace is drawn on each sweep to generate a family of curves.

Limitations, Accuracy, and Correlation

Although the curve tracer is a highly versatile device, it is not capable of every test that one may wish to perform on semiconductor devices such as dv/dt, secondary reverse breakdown, switching speeds, and others. Also, tests at very high currents and/or voltages are difficult to conduct accurately and without damaging the devices. A special high-current test fixture available from Tektronix can extend operation to 200 A pulsed peak. Kelvin contacts available on the 576 and 577 eliminate inaccurate in voltage measured at high current (VTM) by sensing voltage drop due to contact resistance and subtracting from the reading.

Accuracy of the unit is within the published manufacturer’s specification. Allow the curve tracer to warm up and stabilize before testing begins. Always expand the horizontal or vertical scale as far as possible to increase the resolution. Be judicious in recording data from the screen, as the trace line width and scale resolution factor somewhat limit the accuracy of what may be read. Regular calibration checks of the instrument are recommended.

Some users keep a selection of calibrated devices on hand to verify instrument operation when in doubt. Re-calibration or adjustment should be performed only by qualified personnel.

Often discrepancies exist between measurements taken on different types of instrument. In particular, most semiconductor manufacturers use high-speed, computerized test equipment to test devices. They test using very short pulses. If a borderline unit is then measured on a curve tracer, it may appear to be out of specification. The most common culprit here is heat. When a semiconductor device increases in temperature due to current flow, certain characteristics may change, notably gate characteristics on SCRs, gain on transistors, leakage, and so on. It is very difficult to operate the curve tracer in such a way as to eliminate the heating effect. Pulsed or single-trace operation helps reduce this problem, but care should be taken in comparing curve tracer measurements to computer tests. Other factors such as stray capacitances, impedance matching, noise, and device oscillation also may create differences.

Safety (Cautions and Warnings)

Adhere rigidly to Tektronix safety rules supplied with each curve tracer. No attempt should be made to defeat any of the safety interlocks on the device as the curve tracer can produce a lethal shock. Also, older 575 models do not have the safety interlocks as do the new models. Take care never to touch any device or open the terminal while energized.

**WARNING:** Devices on the curve tracer may be easily damaged from electrical overstress.
Follow these rules to avoid destroying devices:

- Familiarize yourself with the expected maximum limits of the device.
- Limit the current with the variable resistor to the minimum necessary to conduct the test.
- Increase power slowly to the specified limit.
- Watch for device “runaway” due to heating.
- Apply and increase gate or base drive slowly and in small steps.
- Conduct tests in the minimum time required.

**General Test Procedures**

**Read all manuals before operating a curve tracer.**

**Perform the following manufacturer’s equipment check:**

1. Turn on and warm up curve tracer, but turn off, or down, all power supplies.
2. Correctly identify terminals of the device to be tested. Refer to the manufacturer’s guide if necessary.
3. Insert the device into the test fixture, matching the device and test terminals.
4. Remove hands from the device and/or close interlock cover.
5. Apply required bias and/or drive.
6. Record results as required.
7. Disconnect all power to the device before removing.

**Model 576 Curve Tracer Procedures**

The following test procedures are written for use with the model 576 curve tracer. (Figure AN1006.1)

See “Model 370 Curve Tracer Procedure Notes” on page AN1006-16 and “Model 577 Curve Tracer Procedure Notes” on page AN1006-18 for setting adjustments required when using model 370 and 577 curve tracers.

The standard 575 model lacks AC mode, voltage greater than 200 V, pulse operations, DC mode, and step offset controls. The 575 MOD122C does allow voltage up to 400 V, including 1500 V in an AC mode. Remember that at the time of design, the 575 was built to test only transistors and diodes. Some ingenuity, experience, and external hardware may be required to test other types of devices.

For further information or assistance in device testing on Tektronix curve tracers, contact the Littelfuse Applications Engineering group.
Figure AN1006.1 Tektronix Model 576 Curve Tracer
Thyristor and Rectifier Testing Using Curve Tracers

**Power Rectifiers**

The rectifier is a unidirectional device which conducts when forward voltage (above 0.7 V) is applied.

To connect the rectifier:

1. Connect Anode to Collector Terminal (C).
2. Connect Cathode to Emitter Terminal (E).

To begin testing, perform the following procedures.

**Procedure 1: \( V_{\text{RRM}} \) and \( I_{\text{RM}} \)**

To measure the \( V_{\text{RRM}} \) and \( I_{\text{RM}} \) parameter:

2. Set **Horizontal** knob to sufficient scale to allow viewing of trace at the required voltage level (100 V/DIV for 400 V and 600 V devices and 50 V/DIV for 200 V devices).
3. Set **Mode** to **Leakage**.
4. Set **Vertical** knob to 100 \( \mu \)A/DIV. (Due to leakage setting, the CRT readout will be 100 nA per division.)
5. Set **Terminal Selector** to **Emitter Grounded-Open Base**.
6. Set **Polarity** to (-).
7. Set **Power Dissipation** to 2.2 W (2 W on 370).
8. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
9. Increase **Variable Collector Supply Voltage** to the rated \( V_{\text{RRM}} \) of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value is the leakage current. (Figure AN1006.2)

![Figure AN1006.2](image1)

**Procedure 2: \( V_{\text{FM}} \)**

Before testing, note the following:

- A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of \( V_{\text{FM}} \) will result due to voltage drop in fixture. If a Kelvin fixture is not available, Figure AN1006.3 shows necessary information to wire a test fixture with Kelvin connections.

- Due to the current limitations of standard curve tracer model 576, \( V_{\text{FM}} \) cannot be tested at rated current without a Tektronix model 176 high-current module. The procedure below is done at \( I_{\text{FM}} \approx 10 \) A (20 \( A_{\text{p}} \)). This test parameter allows the use of a standard curve tracer and still provides an estimate of whether \( V_{\text{FM}} \) is within specification.

![Figure AN1006.3](image2)

To measure the \( V_{\text{FM}} \) parameter:

2. Set **Horizontal** knob to 0.5 V/DIV.
3. Set **Mode** to **Norm**.
4. Set **Vertical** knob to 2 A/DIV.
5. Set **Power Dissipation** to 220 W (100 W on 577).
6. Set **Polarity** to (+).
7. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
8. Increase **Variable Collector Supply Voltage** until current reaches 20 A.

**WARNING:** Limit test time to 15 seconds maximum.

To measure \( V_{\text{FM}} \), follow along horizontal scale to the point where the trace crosses the 20 A axis. The distance from the left-hand side of scale to the crossing point is the \( V_{\text{FM}} \) value. (Figure AN1006.4)

Note: Model 370 current is limited to 10 A.
SCRs

SCRs are half-wave unidirectional rectifiers turned on when current is supplied to the gate terminal. If the current supplied to the gate is to be in the range of 12 μA and 500 μA, then a sensitive SCR is required; if the gate current is between 1 mA and 50 mA, then a non-sensitive SCR is required.

To connect the rectifier:

1. Connect Anode to Collector Terminal (C).
2. Connect Cathode to Emitter Terminal (E).

Note: When sensitive SCRs are being tested, a 1 kΩ resistor must be connected between the gate and the cathode, except when testing \( I_{GT} \).

To begin testing, perform the following procedures.

**Procedure 1:** \( V_{DRM} / V_{RRM} / I_{DRM} / I_{RRM} \)

To measure the \( V_{DRM} / V_{RRM} / I_{DRM} / I_{RRM} \) parameter:

1. Set Variable Collector Supply Voltage Range to appropriate Max Peak Volts for device under test. (Value selected should be equal to or greater than the device's \( V_{DRM} \) rating.)
2. Set Horizontal knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100 V/DIV scale should be used for testing devices having a \( V_{DRM} \) value of 600 V or greater; the 50 V/DIV scale for testing parts rated from 300 V to 500 V, and so on.)
3. Set Mode to Leakage.
4. Set Polarity to (+).
5. Set Power Dissipation to 0.5 W. (0.4 W on 370)
6. Set Terminal Selector to Emitter Grounded-Open Base.
7. Set Vertical knob to approximately ten times the maximum leakage current (\( I_{DRM} / I_{RRM} \)) specified for the device. (For sensitive SCRs, set to 50 μA.)

**Procedure 2:** \( V_{DRM} / I_{DRM} \)

To measure the \( V_{DRM} \) and \( I_{DRM} \) parameter:

1. Set Left-Right Terminal Jack Selector to correspond with location of test fixture.
2. Set Variable Collector Supply Voltage to the rated \( V_{DRM} \) of the device and observe the dot on CRT. Read across horizontally from the dot to the vertical current scale. This measured value is the leakage current. (Figure AN1006.5)

**WARNING:** Do NOT exceed \( V_{DRM} / V_{RRM} \) rating of SCRs, Triacs, or Quadracs. These devices can be damaged.

**Procedure 3:** \( V_{RRM} / I_{RRM} \)

To measure the \( V_{RRM} \) and \( I_{RRM} \) parameter:

1. Set Polarity to (-).
2. Repeat Steps 1 and 2 (\( V_{DRM} / I_{DRM} \)) except substitute \( V_{RRM} \) value for \( V_{DRM} \) (Figure AN1006.6)
Procedure 4: $V_{TM}$

To measure the $V_{TM}$ parameter:

1. Set Terminal Selector to Step Generator-Emitter Grounded.
2. Set Polarity to (+).
3. Set Step/Offset Amplitude to twice the maximum $I_{GT}$ rating of the device (to ensure the device turns on). For sensitive SCRs, set to 2 mA.
4. Set Max Peak Volts to 15 V. (16 V on 370)
5. Set Offset by depressing 0 (zero).
6. Set Rate by depressing Norm.
7. Set Step Family by depressing Rep (repetitive).
8. Set Mode to DC.
9. Set Horizontal knob to 0.5 V/DIV.
10. Set Power Dissipation to 220 W (100 W on 577).
11. Set Number of Steps to 1. (Set steps to 0 (zero) on 370.)
12. Set Vertical knob to a sufficient setting to allow the viewing of 2 times the $I_{T(RMS)}$ rating of the device ($I_{peak}$) on CRT.

Before continuing with testing, note the following:

(1) Due to the excessive amount of power that can be generated in this test, only parts with an $I_{T(RMS)}$ rating of 6 A or less should be tested on standard curve tracer. If testing devices above 6 A, a Tektronix model 176 high-current module is required.

(2) A Kelvin test fixture is required for this test. If a Kelvin fixture is not available, Figure AN1006.3 shows necessary information to wire a test fixture with Kelvin connectors.

13. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
14. Increase Variable Collector Supply Voltage until current reaches rated $I_{peak}$, which is twice the $I_{T(RMS)}$ rating of the SCR under test.

Note: Model 370 current is limited to 10 A.

WARNING: Limit test time to 15 seconds maximum after the Variable Collector Supply has been set to $I_{peak}$. After the Variable Collector Supply Voltage has been set to $I_{peak}$, the test time can automatically be shortened by changing Step Family from repetitive to single by depressing the Single button.

To measure $V_{TM}$, follow along horizontal scale to the point where the trace crosses the $I_{peak}$ value. The distance from the left-hand side of scale to the intersection point is the $V_{TM}$ value. (Figure AN1006.7)

Procedure 5: $I_H$

To measure the $I_H$ parameter:

1. Set Polarity to (+).
2. Set Power Dissipation to 2.2 W. (2 W on 370)
3. Set Max Peak Volts to 75 V. (80 V on 370)
4. Set Mode to DC.
5. Set Horizontal knob to Step Generator.
6. Set Vertical knob to approximately 10 percent of the maximum $I_H$ specified.

Note: Due to large variation of holding current values, the scale may have to be adjusted to observe holding current.

7. Set Number of Steps to 1.
8. Set Offset by depressing 0 (zero). Press Aid and Oppose at the same time on 370.
9. Set Step/Offset Amplitude to twice the maximum $I_{GT}$ of the device.
10. Set Terminal Selector to Step Generator-Emitter Grounded.
11. Set Step Family by depressing Single.
12. Set Left-Right Terminal Jack Selector to correspond with location of test fixture.
13. Increase Variable Collector Supply Voltage to maximum position (100).
14. Set Step Family by depressing Single. (This could possibly cause the dot on CRT to disappear, depending on the vertical scale selected.)
15. Change Terminal Selector from Step Generator-Emitter Grounded to Open Base-Emitter Grounded.
16. Decrease Variable Collector Supply Voltage to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line becomes a dot, represents the holding current value. (Figure AN1006.8)
Procedure 6: $I_{GT}$ and $V_{GT}$

To measure the $I_{GT}$ and $V_{GT}$ parameter:

1. Set Polarity to (+).
2. Set Number of Steps to 1.
3. Set Offset by depressing Aid.
4. Set Offset Multiplier to 0 (zero). (Press Aid and Oppose at the same time on 370.)
5. Set Terminal Selector to Step Generator-Emitter Grounded.
6. Set Mode to Norm.
7. Set Max Peak Volts to 15 V. (16 V on 370)
8. Set Power Dissipation to 2.2 W. (2 W on 370) For sensitive SCRs, set at 0.5 W. (0.4 W on 370)
9. Set Horizontal knob to 2 V/DIV.
10. Set Vertical knob to 50 mA/DIV.
11. Increase Variable Collector Supply Voltage until voltage reaches 12 V on CRT.
12. After 12 V setting is completed, change Horizontal knob to Step Generator.

Procedure 7: $I_{GT}$

To measure the $I_{GT}$ parameter:

1. Set Step/Offset Amplitude to 20% of maximum rated $I_{GT}$
   Note: $R_{ox}$ should be removed when testing $I_{GT}$
2. Set Left-Right Terminal Jack Selector to correspond with location of the test fixture.
3. Gradually increase Offset Multiplier until device reaches the conduction point. (Figure AN1006.9) Measure $I_{GT}$ by following horizontal axis to the point where the vertical line crosses axis. This measured value is $I_{GT}$. (On 370, $I_{GT}$ will be numerically displayed on screen under offset value.)

Procedure 8: $V_{GT}$

To measure the $V_{GT}$ parameter:

1. Set Offset Multiplier to 0 (zero). (Press Aid and Oppose at the same time on 370.)
2. Set Step Offset Amplitude to 20% rated $V_{GT}$
3. Set Left-Right Terminal Jack Selector to correspond with location of test fixture.
4. Gradually increase Offset Multiplier until device reaches the conduction point. (Figure AN1006.10) Measure $V_{GT}$ by following horizontal axis to the point where the vertical line crosses axis. This measured value is $V_{GT}$. (On 370, $V_{GT}$ will be numerically displayed on screen, under offset value.)

Figure AN1006.8  $I_{GT} = 1.2$ mA

Figure AN1006.9  $I_{GT} = 25$ μA

Figure AN1006.10  $V_{GT} = 580$ mV
Triacs are full-wave bidirectional AC switches turned on when current is supplied to the gate terminal of the device. If gate control in all four quadrants is required, then a sensitive gate Triac is needed, whereas a standard Triac can be used if gate control is only required in Quadrants I through III.

To connect the Triac:
1. Connect the Gate to the Base Terminal (B).
2. Connect MT1 to the Emitter Terminal (E).
3. Connect MT2 to the Collector Terminal (C).

To begin testing, perform the following procedures.

Procedure 1: (+)V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, (-)I_{DRM}

Note: The (+) and (-) symbols are used to designate the polarity MT2 with reference to MT1.

To measure the (+)V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, and (-)I_{DRM} parameter:
1. Set Variable Collector Supply Voltage Range to appropriate Max Peak Volts for device under test. (Value selected should be equal to the device’s V_{DRM} rating.)

WARNING: DO NOT exceed V_{DRM}/V_{RRM} rating of SCRs, Triacs, or Quadracs. These devices can be damaged.
2. Set Horizontal knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100 V/DIV scale should be used for testing devices having a V_{DRM} rating of 600 V or greater; the 50 V/DIV scale for testing parts rated from 30 V to 500 V, and so on.)
3. Set Mode to Leakage.
4. Set Polarity to (+).
5. Set Power Dissipation to 0.5 W. (0.4 W on 370)
6. Set Terminal Selector to Emitter Grounded-Open Base.
7. Set Vertical knob to ten times the maximum leakage current (I_{DRM}) specified for the device.

Note: The CRT screen readout should show 1% of the maximum leakage current. The vertical scale is divided by 1,000 when leakage mode is used.

Procedure 2: (+)V_{DRM}, (+)I_{DRM}

To measure the (+)V_{DRM} and (+)I_{DRM} parameter:
1. Set Left-Right Terminal Jack Selector to correspond with location of the test fixture.
2. Increase Variable Collector Supply Voltage to the rated V_{DRM} of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value is the leakage current. (Figure AN1006.11)

Procedure 3: (-)V_{DRM}, (-)I_{DRM}

To measure the (-)V_{DRM} and (-)I_{DRM} parameter:
1. Set Polarity to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of the screen.)

Procedure 4: V_{TM} (Forward and Reverse)

To measure the V_{TM} (Forward and Reverse) parameter:
1. Set Terminal Selector to Step Generator-Emitter Grounded.
2. Set Step/Offset Amplitude to twice the maximum I_{GT} rating of the device (to insure the device turns on).
3. Set Variable Collector Supply Voltage Range to 15 V Max Peak volts. (16 V on 370)
4. Set Offset by depressing 0 (zero).
5. Set Rate by depressing Norm.
7. Set Mode to Norm.
8. Set Horizontal knob to 0.5 V/DIV.
9. Set Power Dissipation to 220 W (100 W on 577).
10. Set Number of Steps to 1.
11. Set Step/Offset Polarity to non-inverted (button extended; on 577 button depressed).
12. Set Vertical knob to a sufficient setting to allow the viewing of 1.4 times the I_{TRMS} rating of the device (I_{Tpeak}) on CRT.

Note the following:
- Due to the excessive amount of power that can be generated in this test, only parts with an I_{TRMS} rating of 8 A or less should be tested on standard curve tracer. If testing devices above 8 A, a Tektronix model 176 high-current module is required.
- A Kelvin test fixture is required for this test. If a
Kelvin fixture is not used, an error in measurement of $V_{TM}$ will result due to voltage drop in fixture. If a Kelvin fixture is not available, Figure AN1006.3 shows necessary information to wire a test fixture with Kelvin connections.

**Procedure 5: $V_{TM}$ (Forward)**

To measure the $V_{TM}$ (Forward) parameter:
1. Set **Polarity** to (+).
2. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
3. Increase **Variable Collector Supply Voltage** until current reaches rated $I_{T(peak)}$ which is 1.4 times $I_{T(RMS)}$ rating of the Triac under test.
   
   Note: Model 370 current is limited to 10 A.

**WARNING:** Limit test time to 15 seconds maximum. After the **Variable Collector Supply Voltage** has been set to $I_{T(peak)}$, the test time can automatically be set to a short test time by changing **Step Family** from repetitive to single by depressing the **Single** button.

To measure $V_{TM}$, follow along horizontal scale to the point where the trace crosses the $I_{T(peak)}$ value. The distance from the left-hand side of scale to the crossing point is the $V_{TM}$ value. (Figure AN1006.12)

![Figure AN1006.12](image)

$V_{TM(Forward)} = 1.1 \text{ V at } I_{PK} = 11.3 \text{ A (8 A rms)}$

**Procedure 6: $V_{TM}$ (Reverse)**

To measure the $V_{TM}$ (Reverse) parameter:
1. Set **Polarity** to (-).
2. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
3. Increase **Variable Collector Supply Voltage** until current reaches rated $I_{T(peak)}$.
4. Measure $V_{TM(Reverse)}$ similar to Figure AN1006.12, except from upper right hand corner of screen.

**Procedure 7: $I_{H(Forward and Reverse)}$**

To measure the $I_{H(Forward and Reverse)}$ parameter:
1. Set **Step/Offset Amplitude** to twice the $I_{GT}$ rating of the device.
2. Set **Power Dissipation** to 10 W.
3. Set **Max Peak Volts** to 75 V. (80 V on 370)
4. Set **Mode** to DC.
5. Set **Horizontal** knob to **Step Generator**.
6. Set **Vertical** knob to approximately 10% of the maximum $I_{H}$ specified.
   
   Note: Due to large variation of holding current values, the scale may have to be adjusted to observe holding current.
7. Set **Number of Steps** to 1.
8. Set **Step/Offset Polarity** to non-inverted (button extended, on 577 button depressed).
9. Set **Offset** by depressing 0 (zero). (Press **Aid** and **Oppose** at same time on 370.)
10. Set **Terminal Selector** to **Step Generator-Emitter Grounded**.

**Procedure 8: $I_{H(Forward)}$**

To measure the $I_{H(Forward)}$ parameter:
1. Set **Polarity** to (+).
2. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
3. Increase **Variable Collector Supply Voltage** to maximum position (100).
4. Set **Step Family** by depressing **Single**.
   
   This could possibly cause the dot on the CRT to disappear, depending on the vertical scale selected.
5. Decrease **Variable Collector Supply Voltage** to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line becomes a dot, represents the holding current value. (Figure AN1006.13)

![Figure AN1006.13](image)

$I_{H(Forward)} = 8.2 \text{ mA}$
Procedure 9: $I_{H(Reverse)}$

To measure the $I_{H(Reverse)}$ parameter:

1. Set **Polarity** to (-).
2. Repeat Procedure 7 measuring $I_{H(Reverse)}$. (Read measurements from upper right corner of the screen.)

Procedure 10: $I_{GT}$

To measure the $I_{GT}$ parameter:

1. Set **Polarity** to (+).
2. Set **Number of Steps** to 1. (Set number of steps to 0 (zero) on 370.)
3. Set **Offset** by depressing **Aid**. (On 577, also set **Zero** button to **Offset**. Button is extended.)
4. Set **Offset Multiplier** to 0 (zero). (Press **Aid** and **Oppose** at same time on 370.)
5. Set **Terminal Selector** to **Step Generator-Emitter Grounded**.
6. Set **Mode** to **Norm**.
7. Set **Max Peak Volts** to 15 V. (16 V on 370)
8. Set **Power Dissipation** to 10 W.
9. Set **Step Family** by depressing **Single**.
10. Set **Horizontal** knob to 2 V/DIV.
11. Set **Vertical** knob to 50 mA/DIV.
12. Set **Step/Offset Polarity** to non-inverted position (button extended, on 577 button depressed).
13. Set **Variable Collector Supply Voltage** until voltage reaches 12 V on CRT.
14. After 12 V setting is completed, change **Horizontal** knob to **Step Generator**.

Procedure 11: $I_{GT}$ - Quadrant I [MT2 (+) Gate (+)]

To measure the $I_{GT}$ - Quadrant I parameter:

1. Set **Step/Offset Amplitude** to approximately 10% of rated $I_{GT}$
2. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
3. Gradually increase **Offset Multiplier** until device reaches conduction point. (Figure AN1006.14) Measure $I_{GT}$ by following horizontal axis to the point where the vertical line passes through the axis. This measured value is $I_{GT}$ (On 370, $I_{GT}$ is numerically displayed on screen under offset value.)

Figure AN1006.14 $I_{GT}$ in Quadrant I = 18.8 mA

Procedure 12: $I_{GT}$ - Quadrant II [MT2 (+) Gate (-)]

To measure the $I_{GT}$ - Quadrant II parameter:

1. Set **Step/Offside Polarity** by depressing **Invert** (release button on 577).
2. Set **Polarity** to (+).
3. Set observed dot to bottom right corner of CRT grid by turning the horizontal position knob. When Quadrant II testing is complete, return dot to original position.
4. Repeat Procedure 11.

Procedure 13: $I_{GT}$ - Quadrant III [MT2 (-) Gate (-)]

To measure the $I_{GT}$ - Quadrant III parameter:

1. Set **Polarity** to (-).
2. Set **Step/Offset Polarity** to non-inverted position (button extended, on 577 button depressed).
3. Repeat Procedure 11. (Figure AN1006.15)

Figure AN1006.15 $I_{GT}$ in Quadrant III = 27 mA
**Procedure 14: I_{GT} - Quadrant IV [MT2 (-) Gate (+)]**

To measure the $I_{GT}$ - Quadrant IV parameter:

1. Set **Polarity** to (-).
2. Set **Step/Offset Polarity** by depressing *Invert* (release button on 577).
3. Set observed dot to top left corner of CRT grid by turning the Horizontal position knob. When Quadrant IV testing is complete, return dot to original position.
4. Repeat Procedure 11.

**Procedure 15: V_{GT}**

To measure the $V_{GT}$ parameter:

1. Set **Polarity** to (+).
2. Set **Number of Steps** to 1. (Set steps to 0 (zero) on 370.)
3. Set **Offset** by depressing *Aid*. (On 577, also set 0 (zero) button to Offset. Button is extended.)
4. Set **Offset Multiplier** to 0 (zero). (Press *Aid* and *Oppose* at same time on 370.)
5. Set **Terminal Selector** to Step Generator-Emitter Grounded.
6. Set **Mode** to Norm.
7. Set **Max Peak Volts** to 15 V. (16 V on 370)
8. Set **Power Dissipation** to 10 W.
9. Set **Step Family** by depressing *Single*.
10. Set **Horizontal** knob to 2 V/DIV.
11. Set **Step/Offset Polarity** to non-inverted position (button extended, on 577 button depressed).
12. Set **Current Limit** to 500 mA (not available on 577).
13. Increase **Variable Collector Supply Voltage** until voltage reaches 12 V on CRT.
14. After 12 V setting is complete, change Horizontal knob to Step Generator.

**Procedure 16: V_{GT} - Quadrant I [MT2 (+) Gate (+)]**

To measure the $V_{GT}$ - Quadrant I parameter:

1. Set **Step/Offset Amplitude** to 20% of rated $V_{GT}$.
2. Set **Left-Right Terminal Jack Selector** to correspond with location of test fixture.
3. Gradually increase **Offset Multiplier** until device reaches conduction point. (Figure AN1006.16) Measure $V_{GT}$ by following horizontal axis to the point where the vertical line passes through the axis. This measured value will be $V_{GT}$. (On 370, $V_{GT}$ will be numerically displayed on screen under offset value.)

**Procedure 17: V_{GT} - Quadrant II [MT2 (+) Gate (-)]**

To measure the $V_{GT}$ - Quadrant II parameter:

1. Set **Step/Offset Polarity** by depressing *Invert* (release button on 577).
2. Set **Polarity** to (+).
3. Set observed dot to bottom right corner of CRT grid by turning the Horizontal position knob. When Quadrant II testing is complete, return dot to original position.
4. Repeat Procedure 16.

**Procedure 18: V_{GT} - Quadrant III [MT2 (-) Gate (-)]**

To measure the $V_{GT}$ - Quadrant III parameter:

1. Set **Polarity** to (-).
2. Set **Step/Offset Polarity** to non-inverted position (button extended, on 577 button depressed).
3. Repeat Procedure 16. (Figure AN1006.17)

**Procedure 19: V_{GT} - Quadrant IV [MT2 (-) Gate (+)]**

To measure the $V_{GT}$ - Quadrant IV parameter:

1. Set **Polarity** to (-).
2. Set **Step/Offset Polarity** by depressing *Invert* (release button on 577).
3. Set observed dot to top left corner of CRT grid by turning the Horizontal position knob. When testing is complete in Quadrant IV, return dot to original position.

4. Repeat Procedure 16.

**Quadracs**

Quadracs are simply Triacs with an internally-mounted DIAC. As with Triacs, Quadracs are bidirectional AC switches which are gate controlled for either polarity of main terminal voltage.

To connect the Quadrac:

1. Connect Trigger to Base Terminal (B).
2. Connect MT1 to Emitter Terminal (E).
3. Connect MT2 to Collector Terminal (C).

To begin testing, perform the following procedures.

**Procedure 1: (+)\(V_{DRM}\), (+)\(I_{DRM}\), (-)\(V_{DRM}\), (-)\(I_{DRM}\)**

Note: The (+) and (-) symbols are used to designate the polarity of MT2 with reference to MT1.

To measure the (+)\(V_{DRM}\), (+)\(I_{DRM}\), (-)\(V_{DRM}\), and (-)\(I_{DRM}\) parameter:

1. Set Variable Collector Supply Voltage Range to appropriate Max Peak Volts for device under test. (Value selected should be equal to or greater than the device’s \(V_{DRM}\) rating).
2. Set Horizontal knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100 V/DIV scale should be used for testing devices having a \(V_{DRM}\) rating of 600 V or greater; the 50 V/DIV scale for testing parts rated from 300 V to 500 V, and so on).
3. Set Mode to Leakage.
4. Set Polarity to (+).
5. Set Power Dissipation to 0.5 W. (0.4 W on 370)
6. Set Terminal Selector to Emitter Grounded-Open Base.
7. Set Vertical knob to ten times the maximum leakage current \(I_{DRM}\) specified for the device.

Note: The CRT readout should show 1% of the maximum leakage current. The vertical scale is divided by 1,000 when the leakage mode is used.

**Procedure 2: (+)\(V_{DRM}\) and (+)\(I_{DRM}\)**

To measure the (+)\(V_{DRM}\) and (+)\(I_{DRM}\) parameter:

1. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
2. Increase Variable Collector Supply Voltage to the rated \(V_{DRM}\) of the device and observe the dot on the CRT. (Read across horizontally from the dot to the vertical current scale.) This measured value is the leakage current. (Figure AN1006.18)

**WARNING:** Do NOT exceed \(V_{DRM}\)/\(V_{RRM}\) rating of SCRs, Triacs, or Quadracs. These devices can be damaged.

**Procedure 3: (-)\(V_{DRM}\) and (-)\(I_{DRM}\)**

To measure the (-)\(V_{DRM}\) and (-)\(I_{DRM}\) parameter:

1. Set Polarity to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of screen).

**Procedure 4: \(V_{BO}\), \(I_{BO}\), \(V_{BO}\)**

**(Quadrac Trigger DIAC or Discrete DIAC)**

To connect the Quadrac:

1. Connect MT1 to Emitter Terminal (E).
2. Connect MT2 to Collector Terminal (C).
3. Connect Trigger Terminal to MT2 Terminal through a 10 \(\Omega\) resistor.

To measure the \(V_{BO}\), \(I_{BO}\), and \(\Delta V_{BO}\) parameter:

1. Set Variable Collector Supply Voltage Range to 75 Max Peak Volts.(80 V on 370)
2. Set Horizontal knob to 10 V/DIV.
3. Set Vertical knob to 50 \(\mu A/DIV\).
4. Set Polarity to AC.
5. Set Mode to Norm.
6. Set Power Dissipation to 0.5 W. (0.4 W on 370)
7. Set Terminal Selector to Emitter Grounded-Open Base.
Procedure 5: $V_{BO}$ (Positive and Negative)

To measure the $V_{BO}$ (Positive and Negative) parameter:

1. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
2. Set Variable Collector Supply Voltage to 55 V (65 V on 370) and apply voltage to the device under test (D.U.T.) using the Left Hand Selector Switch. The peak voltage at which current begins to flow is the $V_{BO}$ value. (Figure AN1006.19)

Procedure 6: $I_{BO}$ (Positive and Negative)

To measure the $I_{BO}$ (Positive and Negative) parameter, at the $V_{BO}$ point, measure the amount of device current just before the device reaches the breakover point. The measured current at this point is the $I_{BO}$ value.

Note: If $I_{BO}$ is less than 10 μA, the current cannot readily be seen on curve tracer.

Procedure 7: $\Delta V_{BO}$ (Voltage Breakover Symmetry)

To measure the $\Delta V_{BO}$ (Voltage Breakover Symmetry) parameter:

1. Measure positive and negative $V_{BO}$ values per Procedure 5.
2. Subtract the absolute value of $V_{BO}$ - from $V_{BO}$ +.
   
   The absolute value of the result is:
   
   $$\Delta V_{BO} = [ |+V_{BO}| - |-V_{BO}| ]$$

Procedure 8: $V_{TM}$ (Forward and Reverse)

To test $V_{TM}$, the Quadrac must be connected the same as when testing $V_{BO}$, $I_{BO}$, and $\Delta V_{BO}$.

To connect the Quadrac:

1. Connect $MT1$ to Emitter Terminal (E).
2. Connect $MT2$ to Collector Terminal (C).
3. Connect Trigger Terminal to $MT2$ Terminal through a 10 Ω resistor.

Procedure 9: $V_{TM}$ (Forward)

To measure the $V_{TM}$ (Forward) parameter:

1. Set Polarity to (+).
2. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
3. Increase Variable Collector Supply Voltage until current reaches rated $I_{peak}$, which is 1.4 times the $I_{rms}$ rating of the Triac under test.

Note: Model 370 current is limited to 10 A.

WARNING: Limit test time to 15 seconds maximum.

4. To measure $V_{TM}$, follow along horizontal scale to the point where the trace crosses the $I_{peak}$ value. This horizontal distance is the $V_{TM}$ value. (Figure AN1006.20)
Procedure 10: \( V_{\text{TM(Reverse)}} \)

To measure the \( V_{\text{TM(Reverse)}} \) parameter:

1. Set **Polarity** to (-).
2. Set **Left-Right Terminal Jack Selector** to correspond with the location of the test fixture.
3. Increase **Variable Collector Supply Voltage** until current reaches rated \( I_{\text{peak}} \).
4. Measure \( V_{\text{TM(Reverse)}} \) the same as in Procedure 8. (Read measurements from upper right corner of screen).

Procedure 11: \( I_{\text{H(Forward and Reverse)}} \)

For these steps, it is again necessary to connect the **Trigger** to \( MT2 \) through a 10 \( \Omega \) resistor. The other connections remain the same.

To measure the \( I_{\text{H(Forward and Reverse)}} \) parameter:

1. Set **Power Dissipation** to 50 W.
2. Set **Max Peak Volts** to 75 V. (80 V on 370)
3. Set **Mode** to DC.
4. Set **Horizontal** knob to 5 V/DIV.
5. Set **Vertical** knob to approximately 10% of the maximum \( I_{\text{H}} \) specified. 
   
   Note: Due to large variations of holding current values, the scale may have to be adjusted to observe holding current.
6. Set **Terminal Selector** to *Emitter Grounded-Open Base*.

Procedure 12: \( I_{\text{H(Forward)}} \)

To measure the \( I_{\text{H(Forward)}} \) parameter:

1. Set **Polarity** to (+).
2. Set **Left-Right Terminal Jack Selector** to correspond with the location of the test fixture.
3. Increase **Variable Collector Supply Voltage** to maximum position (100).
   
   Note: Depending on the vertical scale being used, the dot may disappear completely from the screen.
4. Decrease **Variable Collector Supply Voltage** to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line changes to a dot, represents the \( I_{\text{H}} \) value. (Figure AN1006.21)

Procedure 13: \( I_{\text{H(Reverse)}} \)

To measure the \( I_{\text{H(Reverse)}} \) parameter:

1. Set **Polarity** to (-).
2. Continue testing per Procedure 12 for measuring \( I_{\text{H(Reverse)}} \).

**SIDACs**

The SIDAC is a bidirectional voltage-triggered switch. Upon application of a voltage exceeding the SIDAC breakover voltage point, the SIDAC switches on through a negative resistance region (similar to a DIAC) to a low on-state voltage. Conduction continues until current is interrupted or drops below minimum required holding current.

To connect the SIDAC:

1. Connect \( MT1 \) to the *Emitter Terminal* (E).
2. Connect \( MT2 \) to the *Collector Terminal* (C).

To begin testing, perform the following procedures.

Procedure 1: \( (+) V_{\text{DRM}}, (+)I_{\text{DRM}}, (-) V_{\text{DRM}}, (-)I_{\text{DRM}} \)

Note: The (+) and (-) symbols are used to designate the polarity of MT2 with reference to MT1.

To measure the \( (+) V_{\text{DRM}}, (+)I_{\text{DRM}}, (-) V_{\text{DRM}}, (-)I_{\text{DRM}} \) parameter:

1. Set **Variable Collector Supply Voltage Range** to 1500 Max Peak Volts.
2. Set **Horizontal** knob to 50 V/DIV.
3. Set **Mode** to Leakage.
4. Set **Polarity** to (+).
5. Set **Power Dissipation** to 2.2 W. (2 W on 370)
6. Set **Terminal Selector** to *Emitter Grounded-Open Base*.
7. Set **Vertical** knob to 50 \( \mu A/DIV \). (Due to leakage mode, the CRT readout will show 50 nA.)
Procedure 2: (+) $V_{DRM}$ and (+) $I_{DRM}$

To measure the (+) $V_{DRM}$ and (+) $I_{DRM}$ parameter:

1. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
2. Increase Variable Collector Supply Voltage to the rated $V_{DRM}$ of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value is the leakage current. (Figure AN1006.22)

Procedure 3: (-) $V_{DRM}$ and (-) $I_{DRM}$

To measure the (-) $V_{DRM}$ and (-) $I_{DRM}$ parameter:

1. Set Polarity to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of the screen).

Procedure 4: $V_{BO}$ and $I_{BO}$

To measure the $V_{BO}$ and $I_{BO}$ parameter:

1. Set Variable Collector Supply Voltage Range to 1500 Max Peak Volts. (2000 V on 370)
2. Set Horizontal knob to a sufficient scale to allow viewing of trace at the required voltage level (50 V/DIV for 95 V to 215 V $V_{BO}$ range devices and 100 V/DIV for devices having $V_{BO}$ ≥ 15 V).
3. Set Vertical knob to 50 A/DIV.
4. Set Polarity to AC.
5. Set Mode to Norm.
6. Set Power Dissipation to 10 W.
7. Set Terminal Selector to Emitter Grounded-Open Base.
8. Set Left-Right Terminal Jack Selector to correspond with location of test fixture.
9. Increase Variable Collector Supply Voltage until device breaks over and turns on. (Figure AN1006.24)

Procedure 5: $V_{BO}$

To measure the $V_{BO}$ parameter, increase Variable Collector Supply Voltage until breakover occurs. (Figure AN1006.23) The voltage at which current begins to flow and voltage on CRT does not increase is the $V_{BD}$ value.

Procedure 6: $I_{BO}$

To measure the $I_{BO}$ parameter, at the $V_{BO}$ point, measure the amount of device current just before the device reaches the breakover mode. The measured current at this point is the $I_{BD}$ value.

Note: If $I_{BO}$ is less than 10 μA, the current cannot readily be seen on the curve tracer.

Procedure 7: $I_{H(Forward and Reverse)}$

To measure the $I_{H(Forward and Reverse)}$ Parameter:

1. Set Variable Collector Supply Voltage Range to 1500 Max Peak Volts (400 V on 577; 2000 V on 370).
2. Set Horizontal knob to a sufficient scale to allow viewing of trace at the required voltage level (50 V/DIV for devices with $V_{BO}$ range from 95 V to 215 V and 100 V/DIV for devices having $V_{BO}$ ≥ 215 V).
3. Set Vertical knob to 20% of maximum holding current specified.
4. Set Polarity to AC.
5. Set Mode to Norm.
6. Set Power Dissipation to 220 W (100 W on 577).
7. Set Terminal Selector to Emitter Grounded-Open Base.
8. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
9. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
10. WARNING: Limit test time to 15 seconds maximum.
3. To measure $V_{TM}$, follow along horizontal scale to the point where the trace crosses the $I_{TPK}$ value. This horizontal distance is the $V_{TM}$ value. (Figure AN1006.25)

![Figure AN1006.25 V_{TM} (Forward) = 950 mV at I_{PK} = 1.4 A](image)

**Procedure 10: $V_{TM}$(Reverse)**

To measure the $V_{TM}$(Reverse) parameter:

1. Set Polarity to (-).
2. Repeat Procedure 8 to measure $V_{TM}$(Reverse).

**DIACs**

DIACs are voltage breakdown switches used to trigger-on Triacs and non-sensitive SCRs in phase control circuits.

Note: DIACs are bi-directional devices and can be connected in either direction.

To connect the DIAC:

Connect one side of the DIAC to the Collector Terminal (C). Connect other side of the DIAC to the Emitter Terminal (E).

To begin testing, perform the following procedures.

**Procedure 1: Curve Tracer Setup**

To set the curve tracer and begin testing:

1. Set Variable Collector Supply Voltage Range to 75 Max Peak Volts. (80 V on 370)
2. Set Horizontal knob to sufficient scale to allow viewing of trace at the required voltage level (10 V to 20 V/DIV depending on device being tested).
3. Set Vertical knob to 50 μA/DIV.
4. Set Polarity to AC.
5. Set Mode to Norm.
6. Set Power Dissipation to 0.5 W. (0.4 W on 370)
7. Set Terminal Selector to Emitter Grounded-Open Base.

**Procedure 9: $V_{TM}$(Forward)**

To measure the $V_{TM}$(Forward) parameter:

1. Set Left-Right Terminal Jack Selector to correspond with the location of the test fixture.
2. Increase Variable Collector Supply Voltage until current reaches rated $I_{TPK}$, which is 1.4 times the $I_{TPK}$ rating of the SIDAC.
3. Set Vertical knob to 50 μA/DIV.
4. Set Polarity to AC.
5. Set Mode to Norm.
6. Set Power Dissipation to 0.5 W. (0.4 W on 370)
7. Set Terminal Selector to Emitter Grounded-Open Base.

**Procedure 8: $V_{TM}$(Forward and Reverse)**

To measure the $V_{TM}$(Forward and Reverse) parameter:

1. Set Variable Collector Supply Voltage Range to 350 Max Peak Volts. (400 V on 370)
2. Set Horizontal knob to 0.5 V/DIV.
3. Set Vertical knob to 0.5 A/DIV.
4. Set Polarity to (+).
5. Set Mode to Norm.
6. Set Power Dissipation to 220 W (100 W on 577).
7. Set Terminal Selector to Emitter Grounded-Open Base.

Before continuing with testing, note the following:

- A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of $V_{TM}$ will result due to voltage drop in fixture. If a Kelvin fixture is not available, Figure AN1006.3 shows necessary information to wire a test fixture with Kelvin Connections.

To continue testing, perform the following procedures.

**WARNING:** Limit test time to 15 seconds.
Procedure 2: $V_{BO}$

To measure the $V_{BO}$ parameter:

1. Set **Left-Right Terminal Jack Selector** to correspond with the location of the test fixture.
2. Set **Variable Collector Supply Voltage** to 55 V (65 V for 370) and apply voltage to device under test (D.U.T.), using **Left-Right-Selector Switch**. The peak voltage at which current begins to flow is the $V_{BO}$ value. (Figure AN1006.26)

![Figure AN1006.26: (+)$V_{BO} = 35$ V, (-)$V_{BO} = 36$ V, (±)$I_{BO} < 15$ μA, (–) $I_{BO} < 10$ μA and Cannot Be Read Easily]

Procedure 3: $I_{BO}$

To measure the $I_{BO}$ parameter, at the $V_{BO}$ point, measure the amount of device current just before the device reaches the breakover mode. The measured current at this point is the $I_{BO}$ value.

Note: If $I_{BO}$ is less than 10 μA, the current cannot readily be seen on the curve tracer.

Procedure 4: $\Delta V_{BO}$

To measure the $\Delta V_{BO}$ (Voltage Breakover Symmetry) parameter:

1. Measure positive and negative values of $V_{BO}$ as shown in Figure AN1006.26.
2. Subtract the absolute value of $V_{BO}(-)$ from $V_{BO}(+)$.

   The absolute value of the result is:

   $\Delta V_{BO} = |1 + V_{BO}| - |1 - V_{BO}|$

Model 370 Curve Tracer Procedure Notes

Because the curve tracer procedures in this application note are written for the Tektronix model 576 curve tracer, certain settings must be adjusted when using model 370. Variable Collector Supply Voltage Range and Power Dissipation controls have different scales than model 576. The following table shows the guidelines for setting Power Dissipation when using model 370. (Figure AN1006.27)

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 370</th>
</tr>
</thead>
<tbody>
<tr>
<td>If power dissipation is 0.1 W, set at 0.08 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 0.5 W, set at 0.4 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 2.2 W, set at 2 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 10 W, set at 10 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 50 W, set at 50 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 220 W, set at 220 W.</td>
<td></td>
</tr>
</tbody>
</table>

Although the maximum power setting on the model 370 curve tracer is 200 W, the maximum collector voltage available is only 400 V at 220 W. The following table shows the guidelines for adapting Collector Supply Voltage Range settings for model 370 curve tracer procedures:

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 370</th>
</tr>
</thead>
<tbody>
<tr>
<td>If voltage range is 15 V set at 16 V.</td>
<td></td>
</tr>
<tr>
<td>If voltage range is 75 V set at 80 V.</td>
<td></td>
</tr>
<tr>
<td>If voltage range is 350 V set at 400 V.</td>
<td></td>
</tr>
<tr>
<td>If voltage range is 1500 V set at 2000 V.</td>
<td></td>
</tr>
</tbody>
</table>

The following table shows the guidelines for adapting terminal selector knob settings for model 370 curve tracer procedures:

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 370</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Step generator (base) is emitter grounded then Base Step generator is emitter common.</td>
<td></td>
</tr>
<tr>
<td>If Emitter grounded is open base then Base open is emitter common.</td>
<td></td>
</tr>
</tbody>
</table>
Model 577 Curve Tracer Procedure Notes

Because the curve tracer procedures in this application note are written for the Tektronix model 576 curve tracer, certain settings must be adjusted when using model 577. Model 576 curve tracer has separate controls for polarity (AC, +, -) and mode (Norm, DC, Leakage), whereas Model 577 has only a polarity control. The following table shows the guidelines for setting Collector Supply Polarity when using model 577. (Figure AN1006.28)

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 577</th>
</tr>
</thead>
<tbody>
<tr>
<td>If using Leakage mode along with polarity setting of +(NPN) and -(PNP), vertical scale divided by 1,000,</td>
<td>set Collector Supply Polarity to either +DC or -DC, depending on polarity setting specified in the procedure. The vertical scale is read directly from the scale on the control knob.</td>
</tr>
<tr>
<td>If using DC mode along with either +(NPN) or -(PNP) polarity,</td>
<td>set Collector Supply Polarity to either +DC or -DC depending on polarity specified.</td>
</tr>
<tr>
<td>If using Norm mode along with either +(NPN) or -(PNP) polarity,</td>
<td>set Collector Supply Polarity to either +(NPN) or -(PNP) per specified procedure.</td>
</tr>
<tr>
<td>If using Norm mode with AC polarity,</td>
<td>set Collector Supply Polarity to AC.</td>
</tr>
</tbody>
</table>

One difference between models 576 and 577 is the Step/Offset Polarity setting. The polarity is inverted when the button is depressed on the Model 576 curve tracer. The Model 577 is opposite — the Step/Offset Polarity is “inverted” when the button is extended and “Normal” when the button is depressed. The Step/Offset Polarity is used only when measuring $I_{GT}$ and $V_{GT}$ of Triacs and Quadracs in Quadrants I through IV.
Also, the Variable Collector Supply Voltage Range and Power Dissipation controls have different scales than model 576. The following table shows the guidelines for setting Power Dissipation when using model 577.

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 577</th>
</tr>
</thead>
<tbody>
<tr>
<td>If power dissipation is 0.1 W, set at 0.15 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 0.5 W, set at 0.6 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 2.2 W, set at 2.3 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 10 W, set at 9 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 50 W, set at 30 W.</td>
<td></td>
</tr>
<tr>
<td>If power dissipation is 220 W, set at 100 W.</td>
<td></td>
</tr>
</tbody>
</table>

Although the maximum power setting on model 576 curve tracer is 220 W (compared to 100 W for model 577), the maximum collector current available is approximately the same. This is due to the minimum voltage range on model 577 curve tracer being 6.5 V compared to 15 V for model 576. The following table shows the guidelines for adapting Collector Voltage Supply Range settings for model 577 curve tracer procedures:

<table>
<thead>
<tr>
<th>Model 576</th>
<th>Model 577</th>
</tr>
</thead>
<tbody>
<tr>
<td>If voltage range is 15 V set at either 6.5 V or 25 V, depending on parameter being tested. Set at 6.5 V when measuring ( V_{TM} ) (to allow maximum collector current) and set at 25 V when measuring ( I_{CT} ) and ( V_{CP} ).</td>
<td></td>
</tr>
<tr>
<td>If voltage range is 75 V set at 100 V.</td>
<td></td>
</tr>
<tr>
<td>If voltage range is 1500 V, set at 1600 V.</td>
<td></td>
</tr>
</tbody>
</table>

![Tektronix Model 577 Curve Tracer](image_url)

Figure AN1006.28  Tektronix Model 577 Curve Tracer

©2008 Littelfuse, Inc.
Specifications are subject to change without notice.
Please refer to http://www.littelfuse.com for current information.