Comparing the CT Version 2 to a Tektronix 577 measurement

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The following tests were carried out to compare the performance of our CT Version 2 instrument against the results documented in the ***Tektronix 577 device testing techniques guide***. This guide can be downloaded from this page : https://w140.com/tekwiki/wiki/577

I first attempted the test as per the TEK instructions as far as possible then repeated the test using my own procedure.

The first issue we have with our unit is that it is very difficult to set current limits where very low currents are being measured, for example in leakage measurements. To overcome this, I added a series resistor to the collector connection to provide suitable current limiting. The only noticeable difference is that the Tek 577 will produce a nice knee in the curve but with a series resistor the knee becomes a slope. This is not considered an issue, as it does still indicate the voltage at which breakdown is starting to occur.

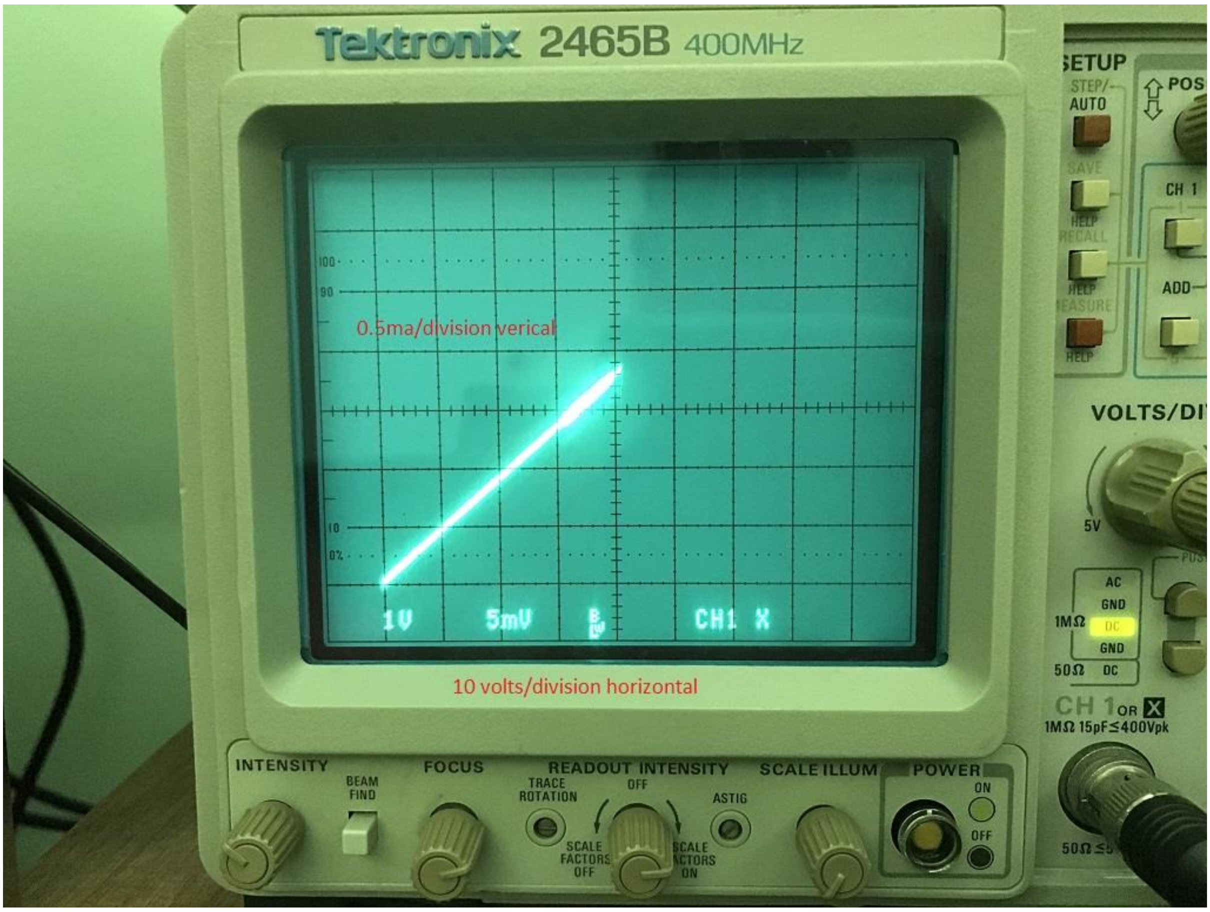
TEST 1 V(br)ceo

This test is measuring the Vce value at which current starts to flow between collector and emitter with the base open. The current will rise very quickly so it must be limited. The Tek guide suggested initial settings of a horizontal voltage scale of 5V/div and a vertical current scale of 0.2ma/div.
My curve tracer was set for 10V/div horizontal scaling and 0.5ma/div vertical scaling.

The datasheet for the 2N3904 states that breakdown should not occur at a value less than 40V with a test current of 1ma.

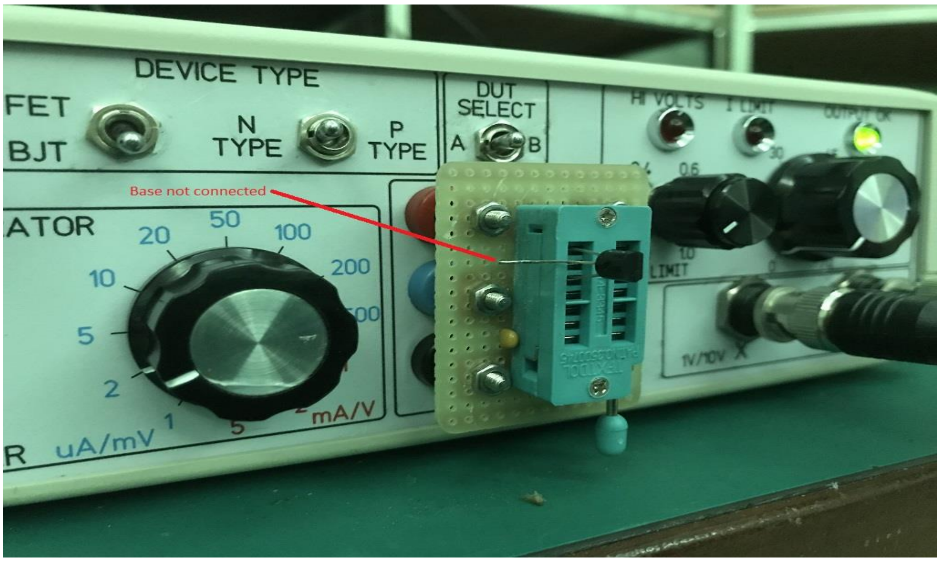
TEK METHOD

This test requires careful control of the maximum available current that can flow between collector and emitter.
The first thing to setup when using our unit is the current limit. This is different from the 577 and I used the following procedure to set this up.
The data sheet tells us that breakdown should not occur at less than 40V Vce.
So let us assume that we need around 45 to 50 VDC to reach breakdown and we have to limit the current at that point to around 2ma. Using ohms law, we can say that at 45V and 2ma we need a resistor of 22.5K. 22K is the closest so install that in your test fixture between collector and emitter. Adjust the voltage to 45V and using the current limit adjust the collector current to around 2ma. This is shown below.

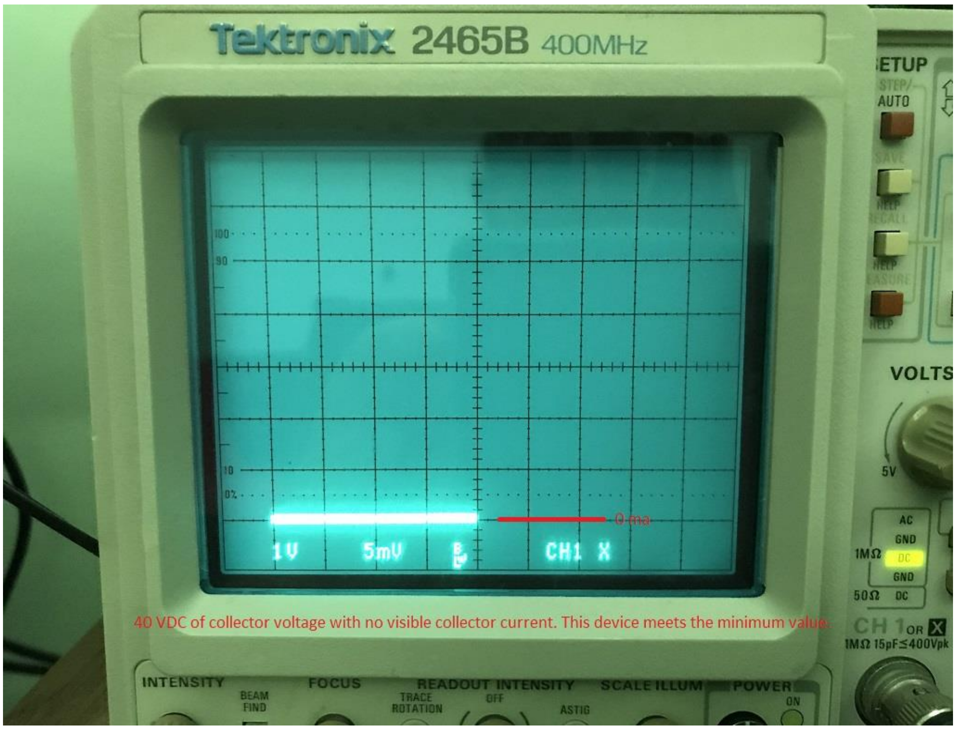


As you can see from the screenshot, we have approximately 42V collector voltage with approximately 1.8ma of collector current. This sets up our test conditions.
DO NOT ADJUST THE CURRENT LIMIT AGAIN!!!

Return the collector voltage to zero, remove the resistor and fit the transistor into the test fixture with the base un-connected. See below.

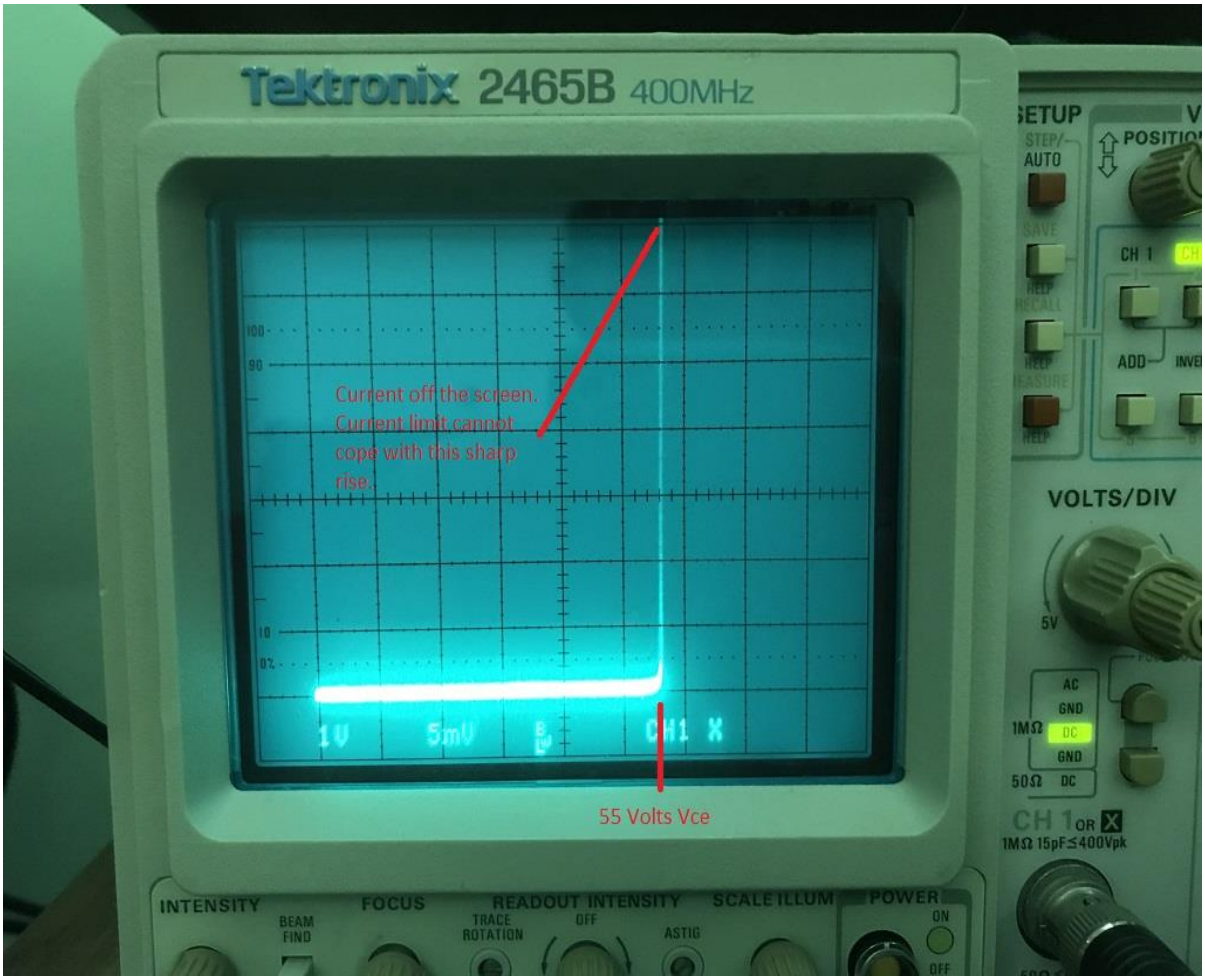


Slowly start to increase the collector voltage until you reach the 40 VDC point. The datasheet gives this voltage as the minimum breakdown voltage. See below.



As you can see from the above screen shot, there is no visible current flowing at the 40V point. This device meets the minimum criteria for this test.

To see where breakdown actually occurs, just for interest's sake, lets increase the voltage and observe what happens. Very slowly, increase the collector voltage and watch closely what is happening to the collector current. As soon as you see a break, stop increasing the voltage.
See below.



As you can see, breakdown has occurred at approx. 55VDC.
The collector current has gone off scale as our current limiting system cannot handle such fast transitions. It does however appear to limit the current sufficiently to prevent component damage. As stated earlier, DO NOT TOUCH THE CURRENT LIMIT WHEN DOING THIS TEST. If you do you will damage the device. Ask me how I know this fact!!!

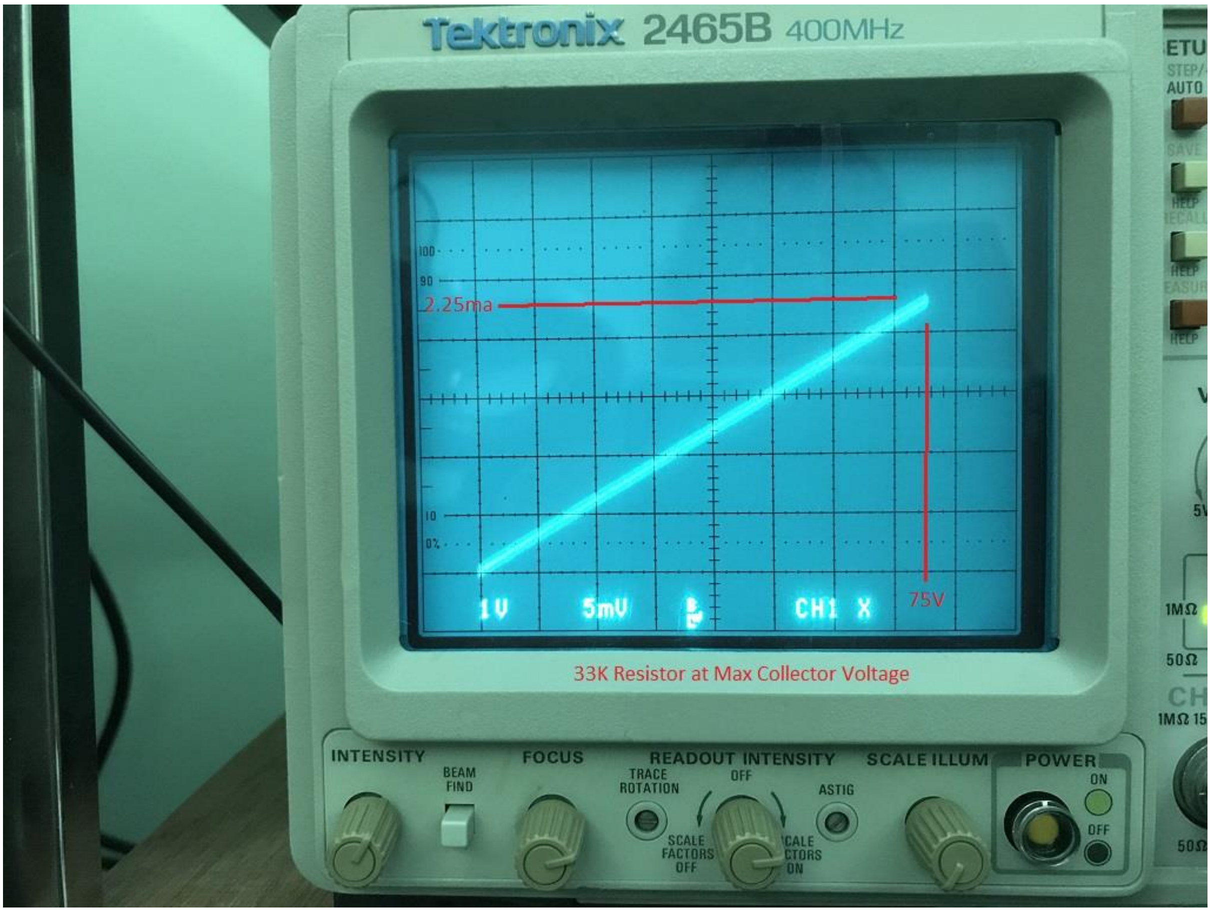
This completes the test as per the TEK procedure.
Now let us try a different approach which is safer to do but produces slightly different responses from the curve tracer.

OUR METHOD

As we already know, we have to take care with the current limiting during this test.
We shall not rely on our built-in current limiting as it cannot cope with the fast transitions seen at the breakdown point. What we shall do instead is to use a resistor to limit the maximum current the CT will provide.

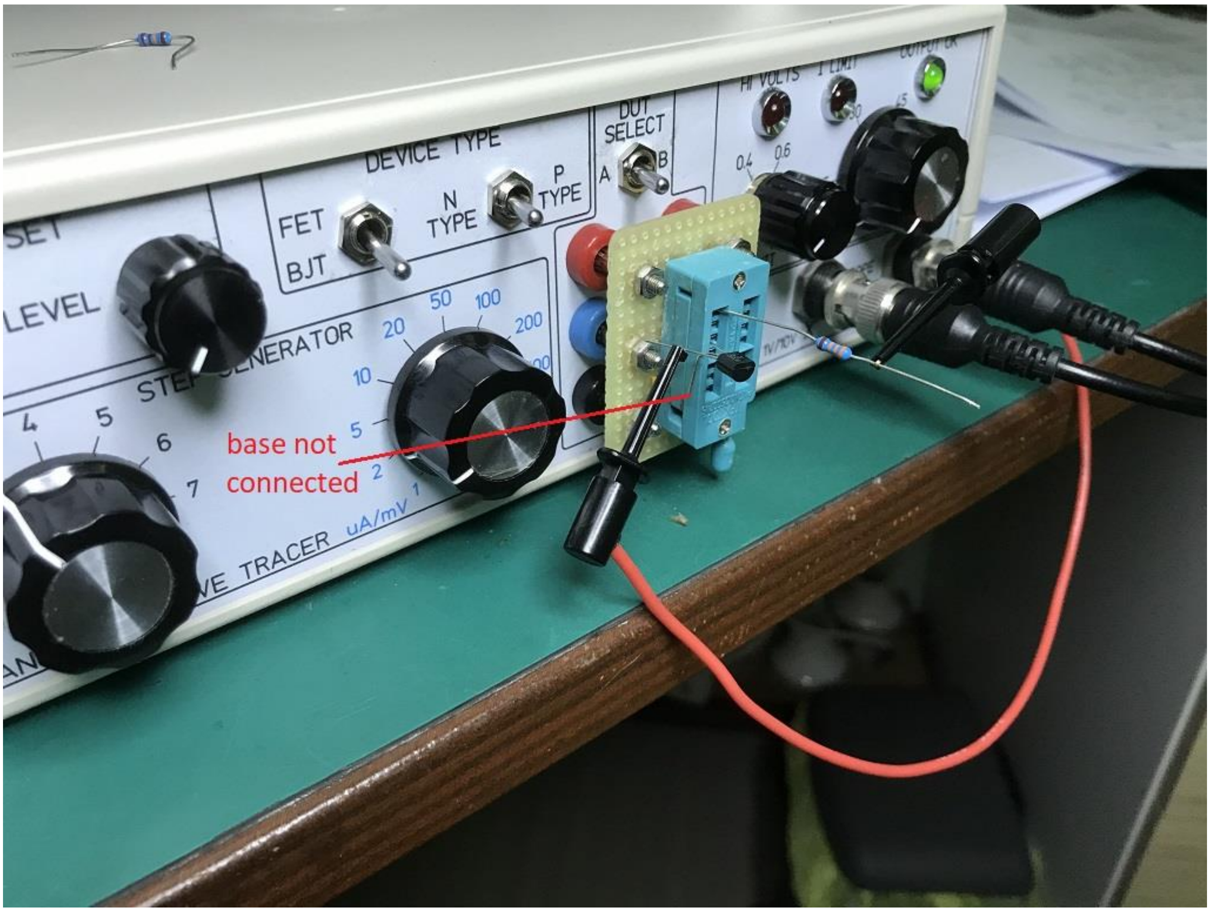
My CT will provide around 75V maximum collector voltage. We need to limit the current to around 2ma to protect the DUT. Based on these requirements we need a resistor of 37.5K to limit the max current to 2ma even if the device decides to go short circuit. I used 33K as it what I had to hand.
Connect your resistor to the test fixture between collector and emitter.

Turn up the collector voltage to max and confirm the current is limited to around 2ma. The position of the current limit control can be fully clockwise as it is the resistor that is now giving us current limit. See below.



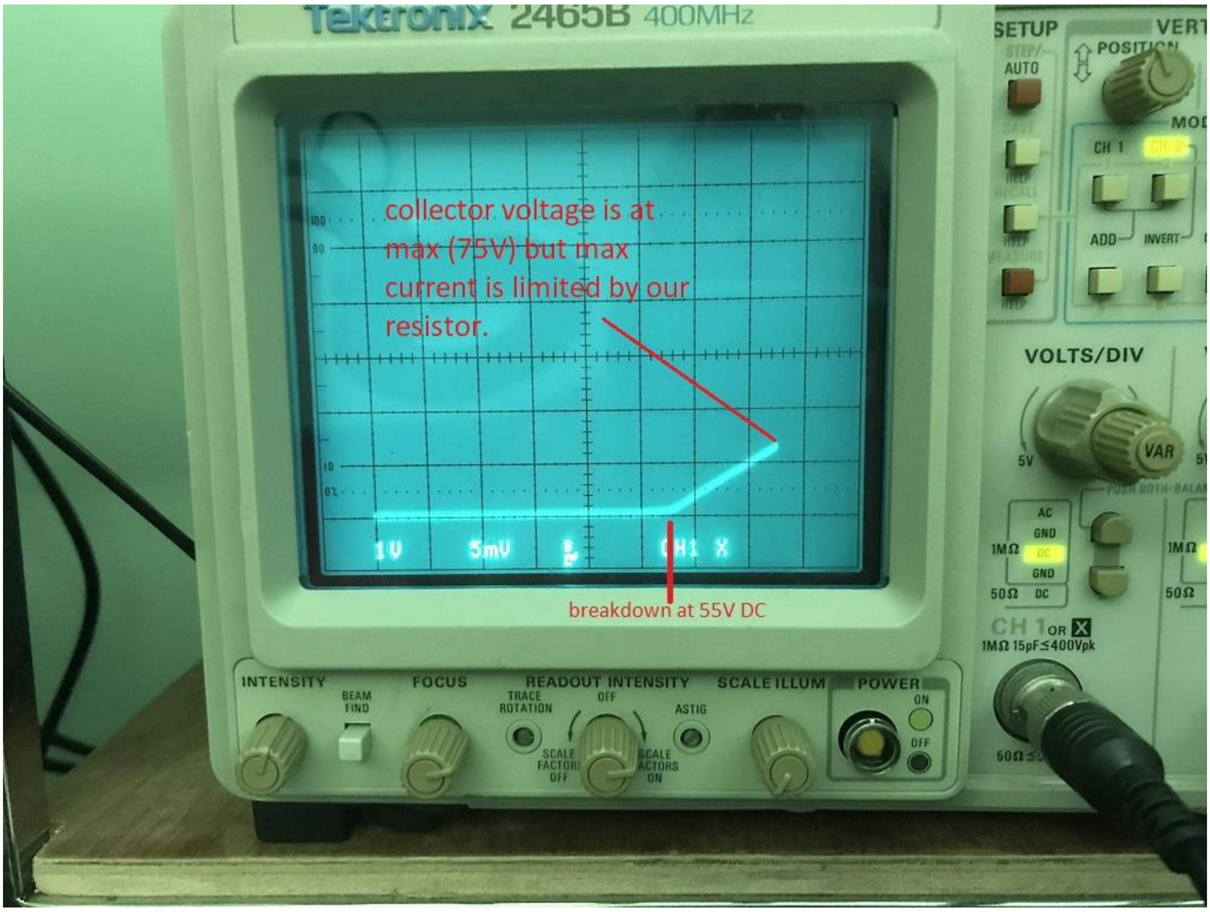
As you can see from the above screen shot, we have a maximum current at 2.25ma at maximum collector voltage of 75V. This should protect the device and we do not need to be so careful with the voltage and current controls.

Remove the resistor from the test fixture and install the transistor emitter only. Base and collector remain outside the ZIF socket.
Insert your 33K resistor into the collector connection on the test fixture and using a short jumper cable, connect it to the transistor collector. See below.



The above shows the test connections. Note the base remains un-connected.

Slowly increase the collector voltage and confirm no current is visible below 40V of applied collector voltage.
Continue to increase the collector voltage slowly, and observe the breakpoint at 55V.
This is the same breakpoint as observed using the TEK procedure.
See below.



The above picture shows the resulting sweep.
Note that the breakpoint is not a vertical trace but a slopping one. This is due to the nature of our current limit.
You can safely continue to increase the voltage all the way to max, the current will never exceed 2ma.

This method provided the same breakpoint value as the TEK procedure but is much safer when using our CT. I would recommend this procedure as it is almost fool proof, providing you follow it as described above.