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Issue: 259 Published: 13 April, 2010

A 1000:1 EHT Probe

Do you need to measure the EHT voltage in a CRT-based scope, computer monitor or TV receiver, or perhaps in a photocopier, laser printer or microwave oven? You'll need an EHT probe to suit your digital multimeter (DMM) to do this and you'll find they are pretty pricey. Not to worry though, because here's one you can build for less than $40.

By Jim Rowe

SAFETY WARNING

In order to use EHT divider probes like the one described in this article safely, please note carefully the following points:

1. **The probe's ground return must always be connected** securely to the 'earthy' side of the EHT circuit in which you are making the measurement – BEFORE you connect the probe's measuring tip to the 'hot' side of the circuit. This is most important because if the probe tip is connected first, all of the probe's internal circuitry AND YOUR DMM will be 'floating' at the full EHT voltage and thus represent a very serious safety risk.

2. The probe's ground return lead and its connection clip must be regarded as a vitally important part of the probe itself. It is crucial to achieving correct probe operation, because it provides the only connection between the bottom end of the probe's voltage divider and the EHT circuit in which you are making the measurement.

3. NEVER connect the probe's ground return lead to the 'hot' side of the high voltage circuit, as this will also cause your DMM to be floating at the full EHT voltage. If you need to measure an EHT voltage that happens to be negative with respect to ground, simply reverse the polarity of the probe lead connections to the DMM input jacks. The probe's ground return lead should ALWAYS be connected to the 'cold' or earthy side of the EHT circuit.

4. If at all possible, turn off the power to the EHT circuit before you connect the probe's ground return lead and

input measuring tip. Only turn the power back on when both connections are secure and your hands are safely withdrawn. This will help ensure that you don't receive a shock when the probe tip comes into contact with the 'hot' side of the EHT circuit, and also that a 'flashover' arc cannot develop.

5. Turn off the power to the EHT circuit again after you have made the measurement, and before you remove the tip and ground return connections (in that order).

6. If it is not feasible to turn off the power to the EHT circuit before making the probe connections and you have to hold the probe body in your hand while making the measurement, make sure you hold it down at the output lead end. Do not risk a flashover or punch-through by holding it closer to the tip end.

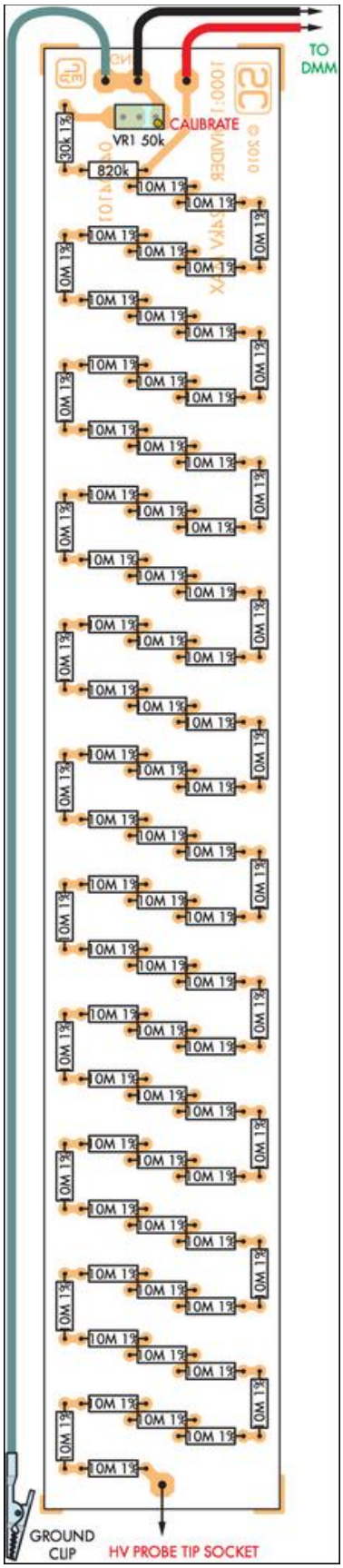
7. **Do not attempt to use this type of probe to make measurements in high voltage power distribution systems.** These can supply a huge amount of energy/power and in most cases cannot be turned off in order to make the probe connections. The risk of serious injury or death is therefore extremely high.

Measuring really high voltages is not something you can normally do easily or safely. So if you want to measure the EHT of CRT-based TV receivers or the corona voltages in photocopiers or laser printers, what do you do?

They are up around 22kV or more – far out of the range of a DMM. And if you want to measure the high voltage in a microwave oven – about 3kV or so – that's also way out of range of a DMM.

Test setup using the EHT Stick and a digital multimeter. Always ensure that the green grounding lead is firmly attached to a suitable ground point in the circuit under test BEFORE probing the EHT.

You can't make this kind of measurement just with a normal multimeter or DMM, because in most cases they have a maximum input voltage rating of 1000VDC or 750VAC.


TO DMM
CALIBRATE
VR1 50k
30k 1%
820k
10M 1%
GROUND CLIP
HV PROBE TIP SOCKET

The only way this type of meter can be used to make measurements on higher voltages is to connect a specially designed EHT divider probe between its input sockets and the source of high voltage. The probe divides down the voltage to be measured by a known factor (usually either 100:1 or 1000:1), to bring it within the voltage range which can be handled safely by the meter itself.

This type of EHT divider probe has been available commercially for many years, and they're still available if you hunt them down.

They've never been particularly cheap though and if you want to buy a brand-new probe nowadays you'll find they're priced from around $100 and upwards – not easy to justify if you only want to measure EHT voltages every now and again.

Our probe, which we've dubbed the "EHT Stick", has been designed to allow you to measure DC voltages up to around 23-25kV, using any standard digital multimeter (DMM) which has an input resistance of 10MΩ. It provides a division ratio of 1000:1, so kilovolts at the input are read simply as volts on the DMM.

Like many commercial EHT probes, it provides an input resistance of just over 800MΩ. So when it's connected across a circuit with a voltage of say 20kV (20,000V), the probe will draw a modest 'loading' current of only 25µA.

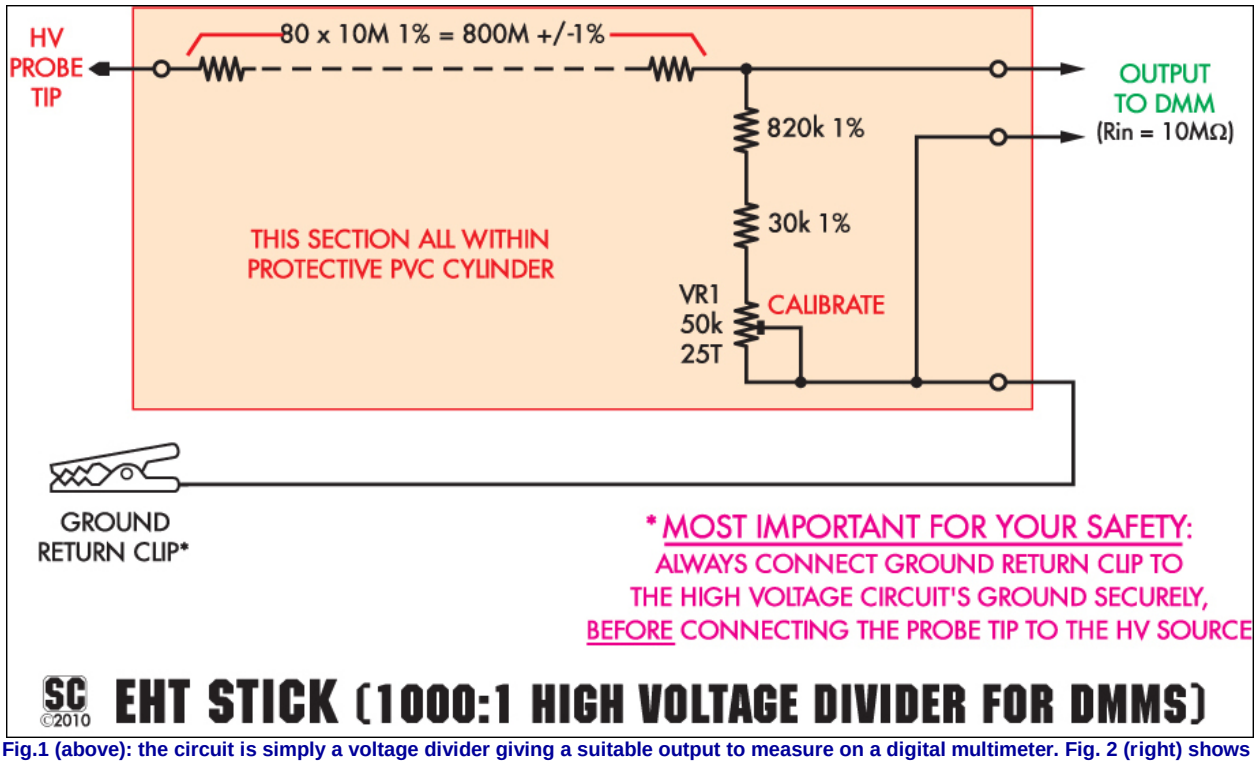


Fig.1 (above): the circuit is simply a voltage divider giving a suitable output to measure on a digital multimeter. Fig. 2 (right) shows the PC board component overlay. It's not difficult to build but it is quite tedious fitting and soldering 82 half-watt resistors. Note: do not substitute other resistors as their voltage rating may be insufficient.

In their divider's crucial input leg, commercial EHT probes have always used special very high value 'long spiral' resistors rated to withstand very high voltages but these haven't been readily available for some time.

So instead, we have used 80 (yes, eighty!) high voltage (1.6kV) 10MΩ 0.5W metal film resistors in series to produce the 800MΩ input leg. The Farnell type number for the 10MΩ is 110-0295.

Because of the large number of resistors in series, the voltage drop per resistor is kept well within their maximum voltage rating.