

Megger DET4TC and DET4TCR with ICLAMP and VCLAMP options

'Clamp On' electrode testing methods



The testing of earth systems has relied for many years on the tried and tested "Fall of Potential" and other related methods. These methods give reliable results, but can be time consuming.

Megger has made an "ART" of testing

Just a little aside

The ICLAMP has the ability to measure very small currents, so Megger used this ability to add yet another benefit. The DET4TC is equipped with an earth leakage range, allowing quick and easy

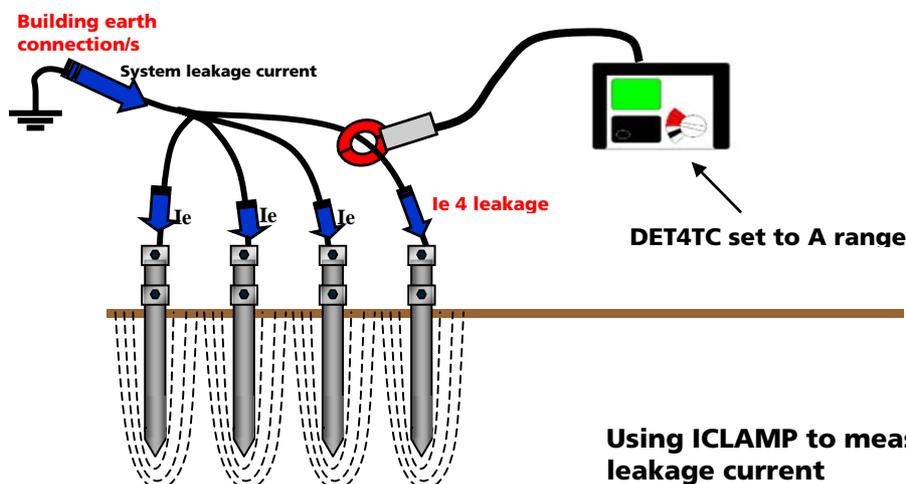
To measure an individual electrode's earth resistance requires the disconnection of the electrode being tested from the rest of the earth system and any connection to a building's earth wiring. This can also involve downtime, or reduce the degree of protection to the installation.

Now Megger has a solution to this problem in the form of A.R.T., the Attached Rod Technique.

When the earth tester injects a test current into an electrode which is still connected to the system, current not only flows down the electrode under test, but back into the building's system, and down any other electrodes connected in parallel.

Megger's new DET4TC together with the optional ICLAMP utilises 'ART' to allow the instrument to measure only the current being injected into the electrode under test. The instrument uses this current to calculate the resistance of the electrode under test. No disconnection, no wasted time, no downtime, no irritation, no scraped knuckles!

measurement of leakage current flowing into the earth system. So if you do need to disconnect an electrode for maintenance there are no nasty surprises!

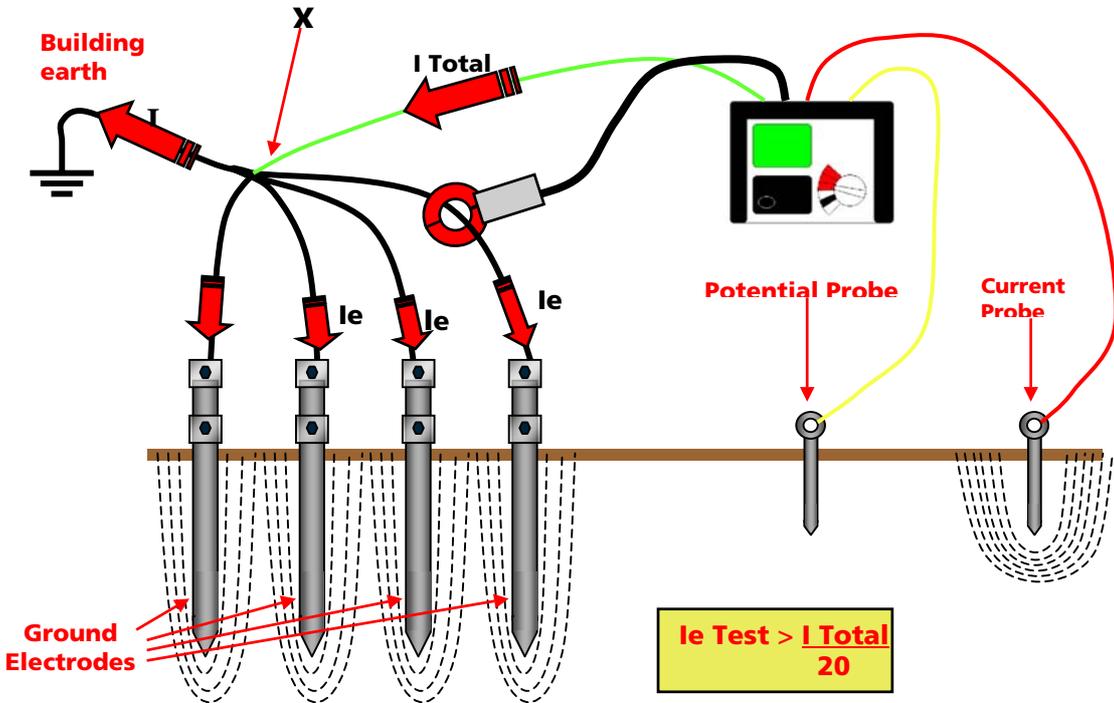


Megger gets down to earth with "ART"

So how does 'ART' work?

The **DET4TC** will perform the traditional 3-pole measurements like other earth testers. When in the normal 3P mode the **DET4TC** injects a test current at 128Hz (X to C terminals), so as not to clash with the generation frequency and its harmonics. The voltage measurement is then taken (X to P terminals) at this frequency, therefore enabling the instrument to ignore other currents flowing in the

earth system. The rest is simply down to ohms law to calculate the resistance as displayed. The addition of the **ICLAMP** now enables only the test current in the individual electrode to be measured. As with the voltage measurement the **ICLAMP** measures the current only at the 128Hz the **DET4TC** generates, again allowing other currents flowing to be ignored.



The diagram above demonstrates the operation of 'ART'

The ICLAMP has the ability to measure an electrode down to 5% of the total test current generated by the instrument. In other words the electrode measured can have a resistance up to 20 times that

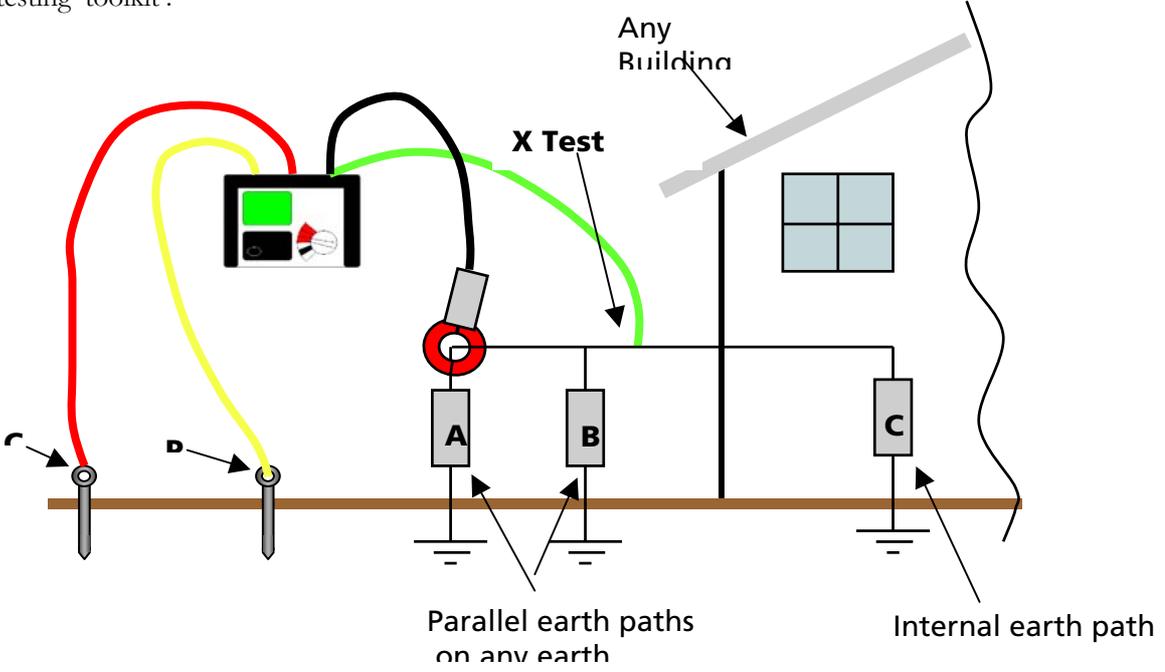
of the total system and still be measured. Values higher than 20 times cannot be measured using 'ART', and so you will need to carry out a traditional 3-pole measurement. See over leaf.

Don't underestimate the power of "ART"

Even if the test current flowing through the electrode under test is less than 5% of the total current generated by the **DET4TC** you can still get an idea of the electrode's resistance. Should this happen the instruments display will show the "clamp low" indication as follows.

So if you take a reading of the complete system in standard 3P mode you know that the electrode you were trying to test is at least 20 times that. That is usually enough information to make a decision. In addition you can also measure the standing leakage current in each individual electrode.

The **DET4TC** with **ICLAMP** is a flexible addition to your testing 'toolkit'.



Let's imagine we were trying to measure the resistance of an earth path 'A' above.

Then using **ICLAMP** the low current symbol, shown above, appeared on the display. In this instance we cannot use **ART**.

You should still perform a standard 3-pole measurement on the complete system.

If the reading is 4.5 ohms. Because we know that the **ICLAMP** requires at least 1/20th of the test current, we now know that resistance 'A' must be at least 90 ohms.

$$\text{Reading } 4.5 \times 20 = 90 \text{ ohms}$$

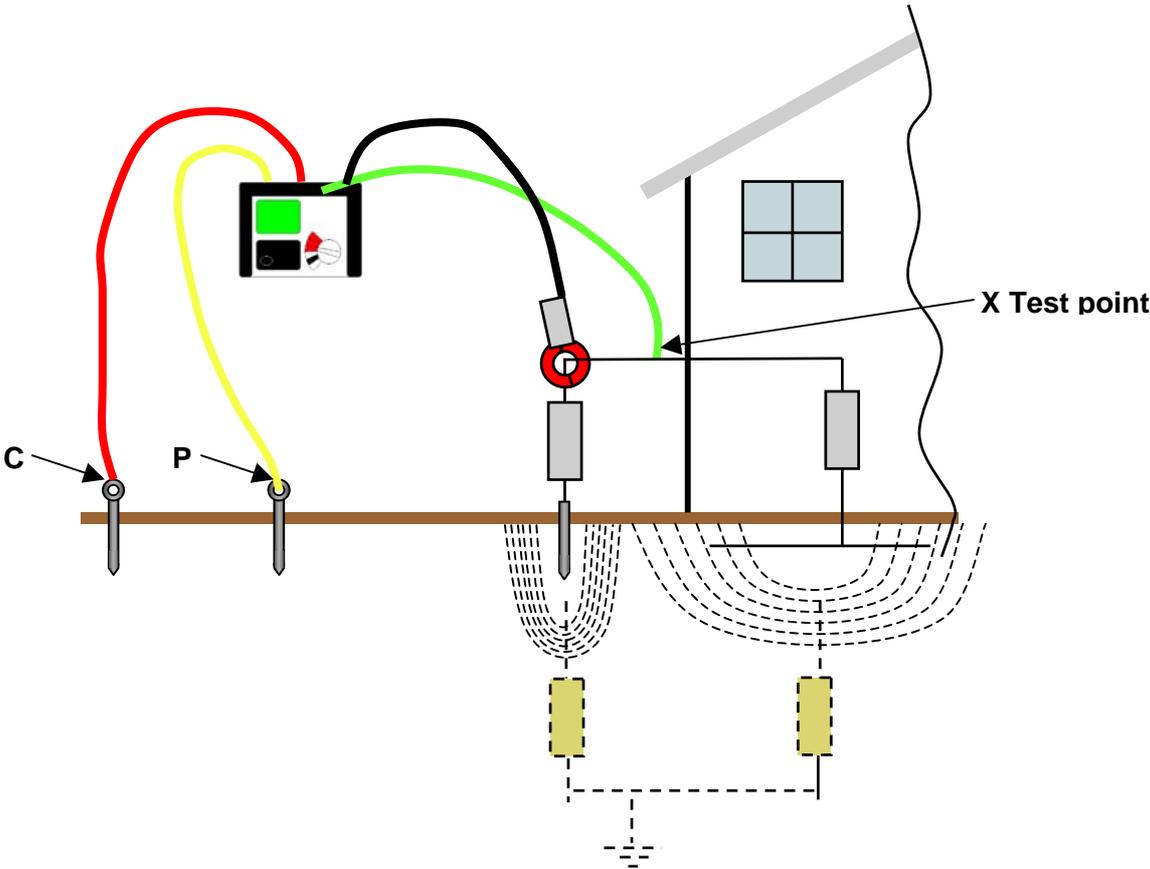
Enough information to know whether the earth path **A**, be it an electrode, connection to a mesh or whatever, needs attention.

The problem with Spheres of Influence

There is another factor to take into account, and that is the sphere of influence around the earth

electrode/s and the buildings earth paths, whether it's through water/gas pipes or metal framework.

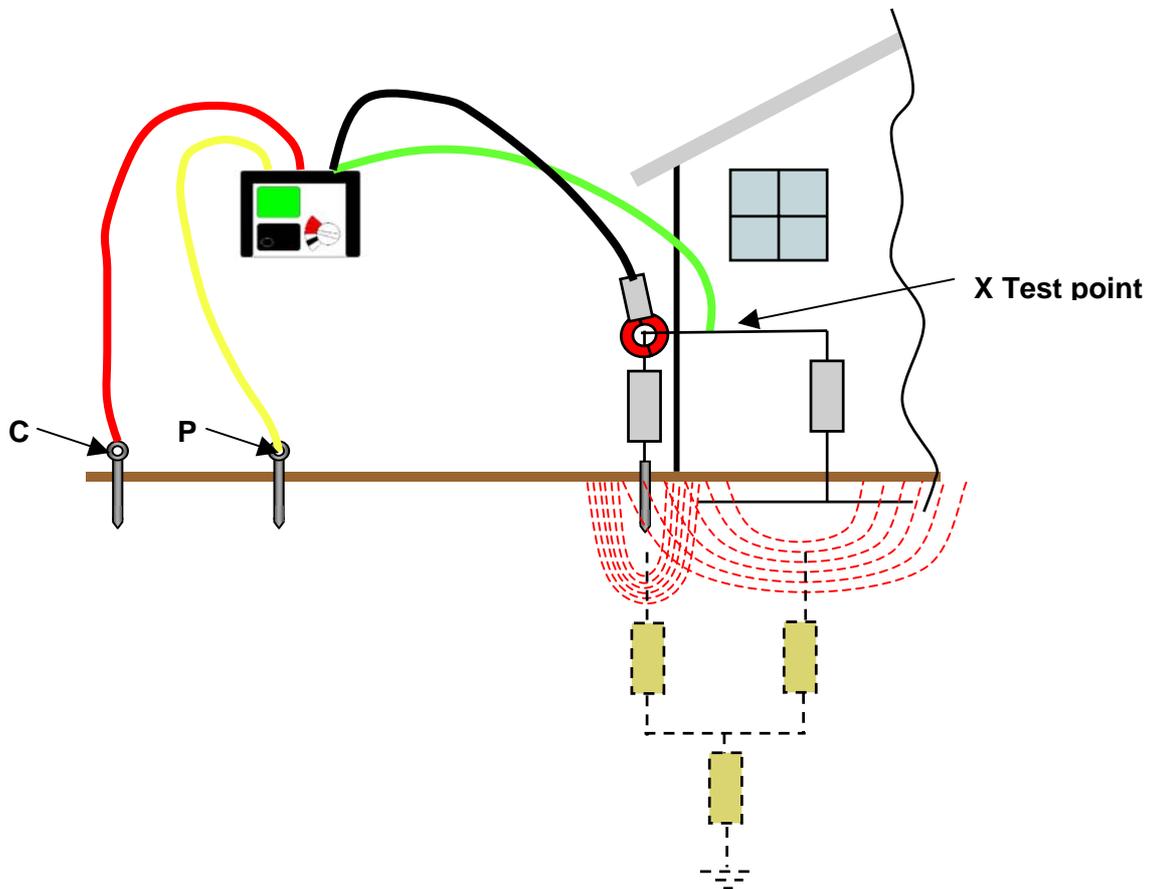
Consider the following diagram;



Here, the spheres of influence are outside each other, resulting in the equivalent circuit shown underneath. **ART** should, subject to the 20:1 rule, work fine.

Note: If you are unclear as to the meaning of “Sphere of Influence”, more information can be found in the Megger publication “Getting down to Earth”, part number 21500-072.

Now look at the next diagram.



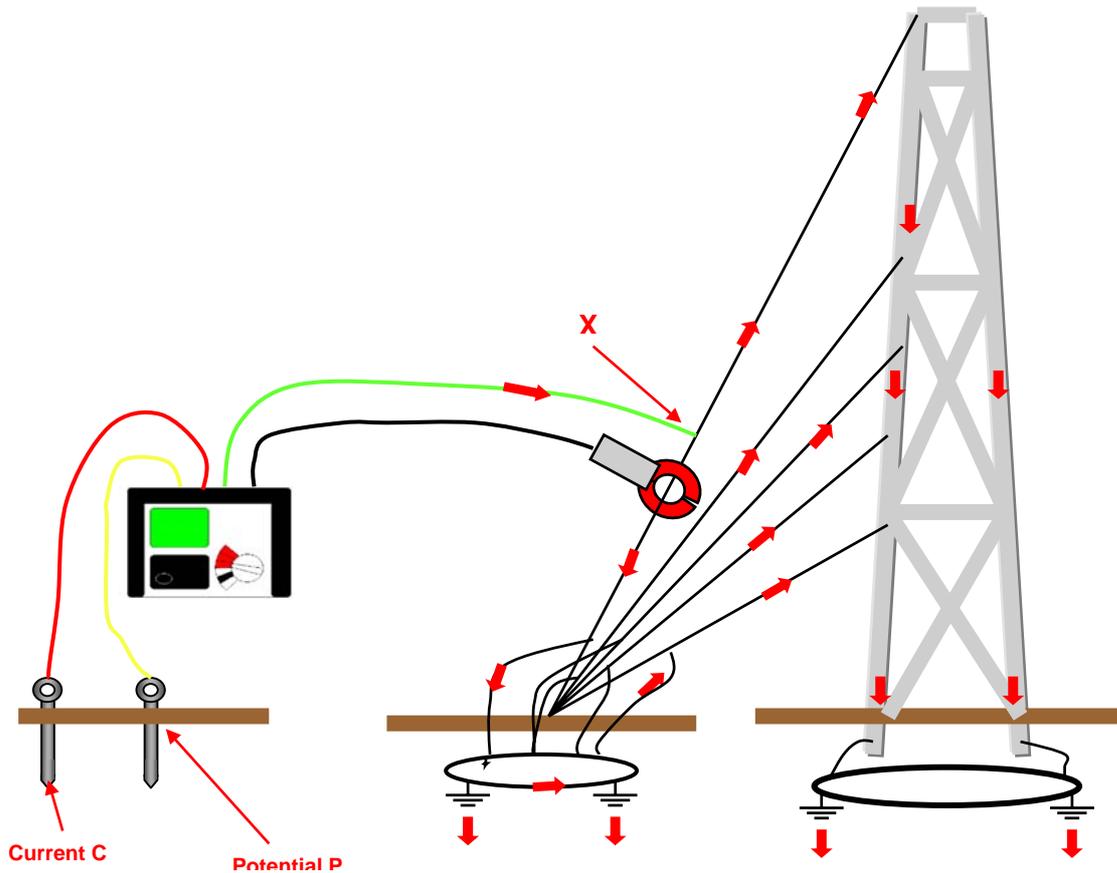
In this situation the electrode under test is very close to the building. The result is the sphere of influence of the electrode and that of the building are overlapping. Effectively we now have “earth coupling” occurring, hence the difference in equivalent circuit.

The overlap in the spheres of influence introduces additional impedances that make resolving the resistance of the electrode difficult using **ART**. The result will cause either be the “clamp low” symbol appearing or an unexpectedly high reading. If this happens proceed with the traditional 3-pole method with the electrode under test disconnected.

We all like “ART” but sometimes it’s misunderstood

Like most modern and new forms of ART sometimes it’s misunderstood, but hopefully we can prevent that happening to you.

Lets look at the following diagram and see if we can spot the error?



The error isn't at first obvious, I want to measure the earth resistance of the guy line with the clamp around it. But the guy lines on this tower are all shorted together. The current being measured by **ICLAMP** is flowing not just to ground at the anchor point, but back up the other guy lines and to

ground via the tower. This means the calculated resistance will be incorrect for the anchor point.

Always consider where the test current is going to flow, all measured test current should flow through the required earth (soil) mass around the electrode under test.

Some resistance to ART

Finally, new **ART** forms can sometimes meet with additional resistance. However with the **DET4TC** we easily ignore such resistance.

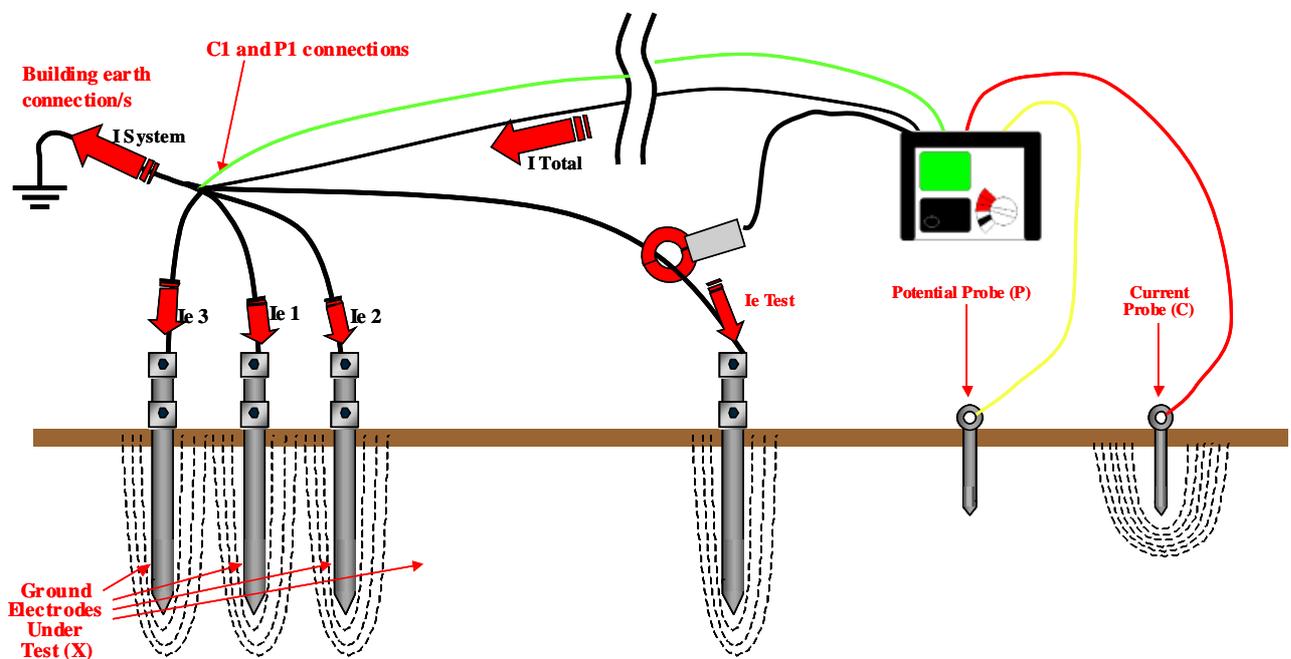
Sometimes it can be difficult to get the instrument close to where we need to make our 'X' connection. The obvious solution is to use a long test lead, but this is going to add additional resistance to our reading. The solution is simple.

Select the 4P plus clamp range to use the ART method with four poles.

Connect both the P1 and C1 terminals to the electrode system under test.

Now the potential measurement is taken at the electrode connection rather than the instrument X terminal.

The result is the lead resistance is totally ignored.



The Best Application of “ART”

There are many applications where **ART** work extremely well.

These include:

- Field of earth / Earth Farms
- Pole mounted transformers
- Domestic TT (earth electrode) systems
- Single guy lines on towers
- Lightning protection electrodes

“STAKELESS” earth electrode testing

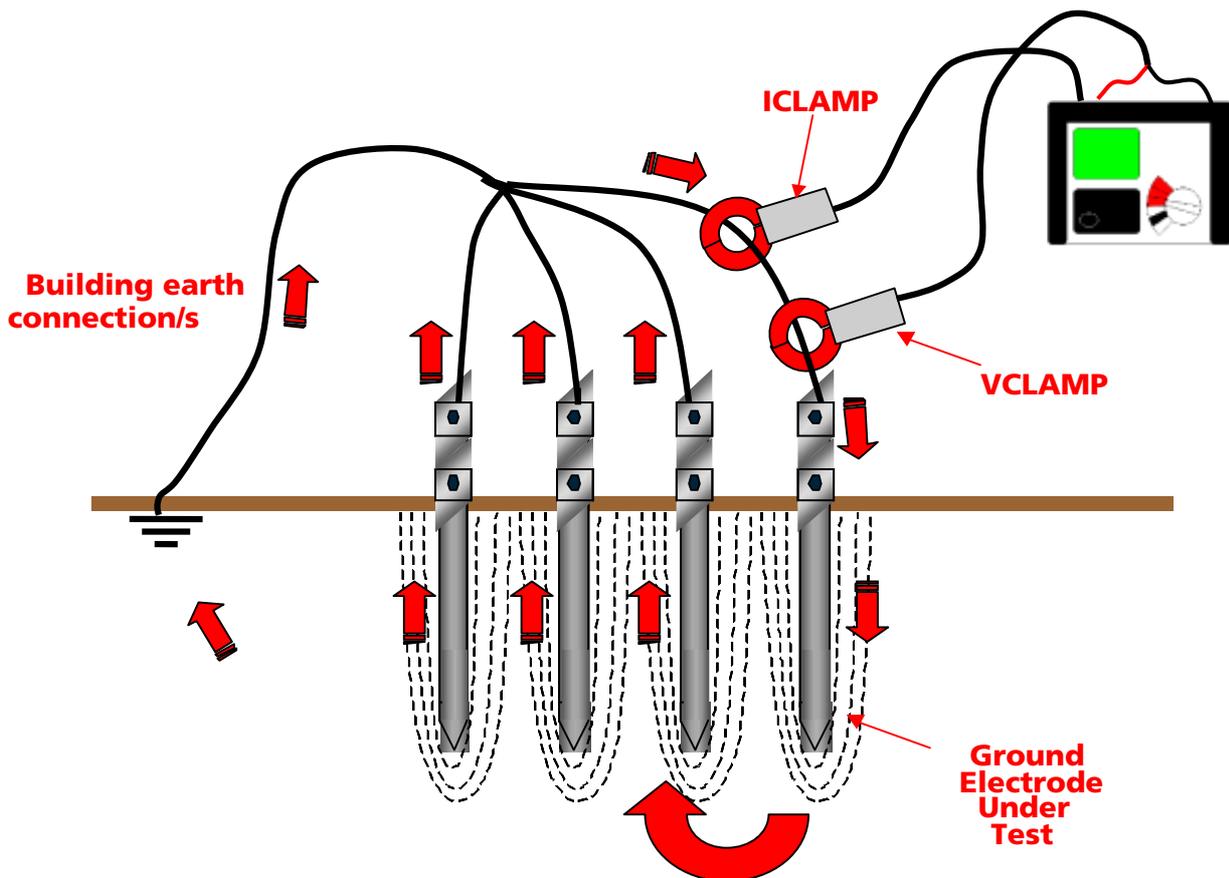
Earth electrode testing can be a difficult and time-consuming business; this is why Megger is committed to making life as easy as possible for you. Our experience of real life situations led to the introduction of **ART**, first seen with the **DET3TC**, and now with the **DET4TC** we add the capability to perform **Stakeless** measurements.

Adding a second clamp, the **VCLAMP**, the **DET4TC** can be used to measure electrode resistance in locations where driving stakes is not practical.

Lets take a look at the test in practice:

To take a measurement simply select the dual clamp range on the **DET4TC**, connect the **ICLAMP** and the **VCLAMP** to the appropriate terminals. Then clamp both of them around the electrode under test (or the cable connected to the electrode) and press the test button, simple. However there are a few simple things to remember.

The first is that there must be at least 100mm gap between the clamps. This is to ensure the field around the clamps do not interfere with each other. The result would be incorrect readings.

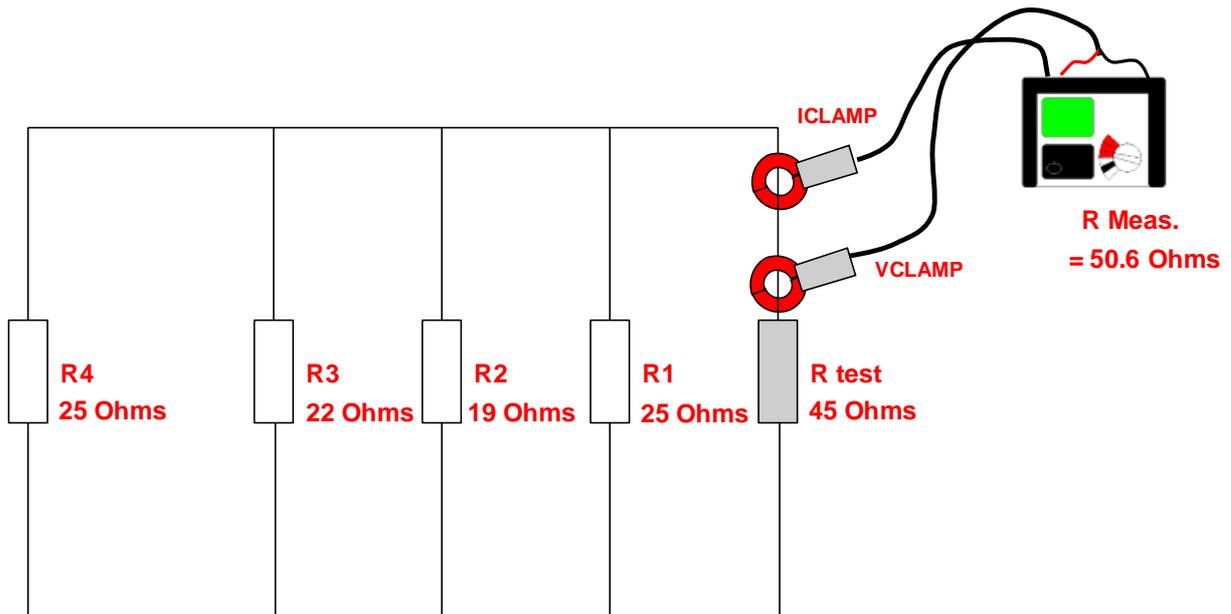


Current is induced into the circuit by the **ICLAMP** and then the resulting voltage is measured with the

VCLAMP. From this the resistance of the complete loop / current path can be measured.

The important thing to remember is that the method measures the resistance of the total loop, where the test current is flowing. So it is important to understand the path the test current is taking.

The equivalent circuit is shown below. It clearly illustrates how the measurement is actually the electrode under test in series with all the other earth paths in parallel. This means the measurement will always be pessimistic, never optimistic.



$$R \text{ Meas.} = R \text{ test} + 1 / (1/R1 + 1/R2 + 1/R3 + 1/R4)$$

Equivalent Circuit

The true resistance of the electrode being measured is 45 Ohms, but as the other earth paths in parallel total 5,6 Ohm this is measured in series, hence the reading is 50.6 Ohms.

In this case, though, there are only four parallel paths, the more parallel paths there are the more accurate the reading becomes. With many parallel earth paths, the reading will become almost identical to the actual value of the earth electrode being measured.

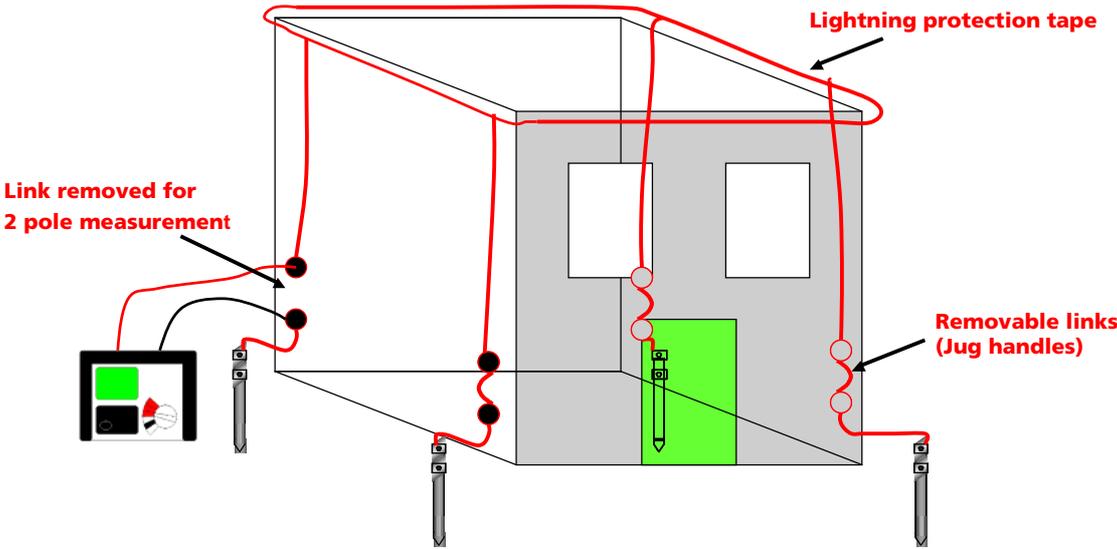
Since the measurement is a complete loop, another useful feature of this measurement is that the resistance of the cables and all connections are measured. So any poor connections will be highlighted too.

The readings taken are ideal for monitoring over time the condition of installations, but without the inconvenience associated with electrode disconnection and the driving in of test stakes.

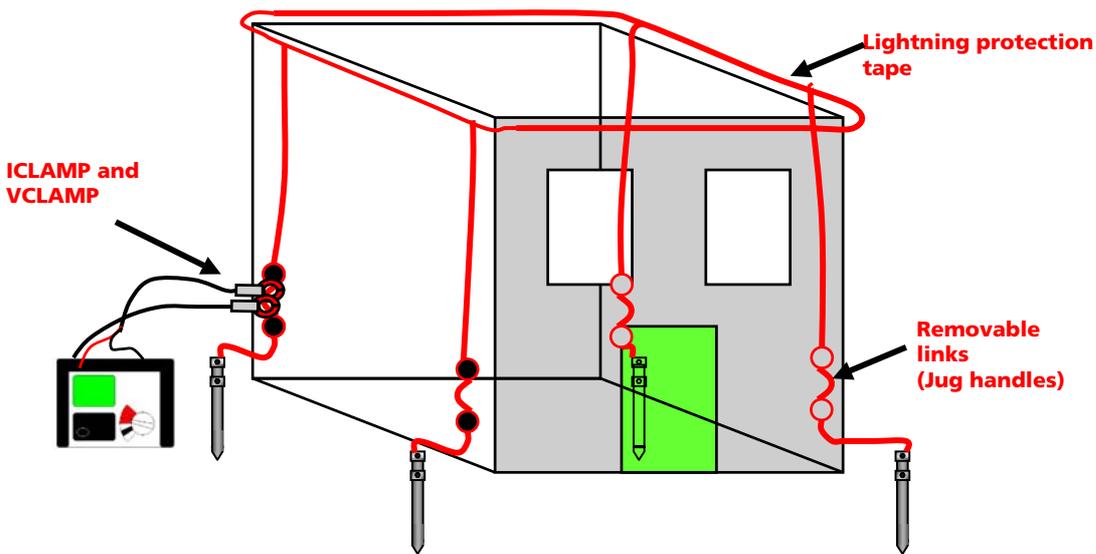
This makes this method particularly suited to measuring lighting protection systems on buildings.

Normally the time consuming practice of removing test links would be required, and a 2-pole test applied.

The normal 2-pole method would be applied as follow:



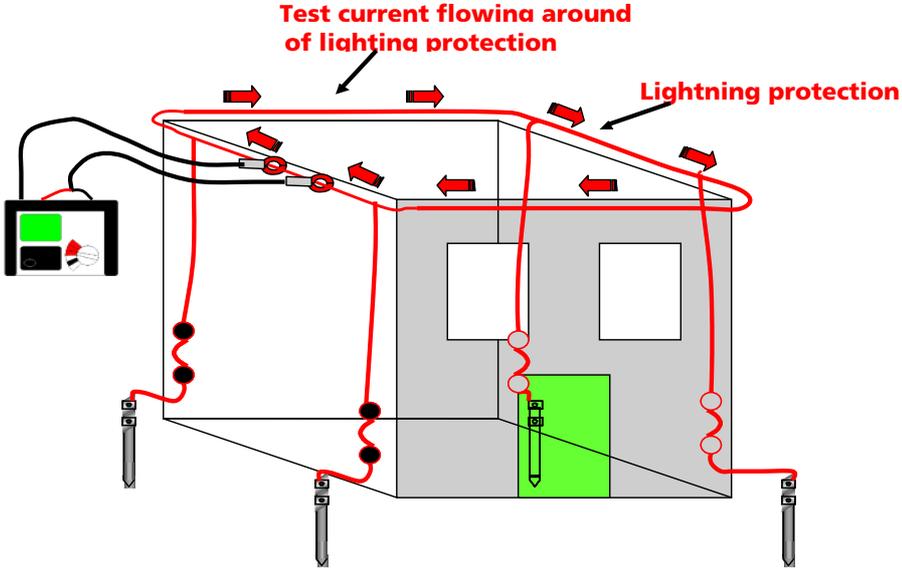
Using the stakeless method negates the requirement to remove these links, just clamp the **ICLAMP** and **VCLAMP** around the tape or link. See below



Incorrect use of Stakeless testing

The stakeless method is not unfortunately, to coin a phrase, miss-stakeless. As with the **ART** method, test current must go through the earth mass to be

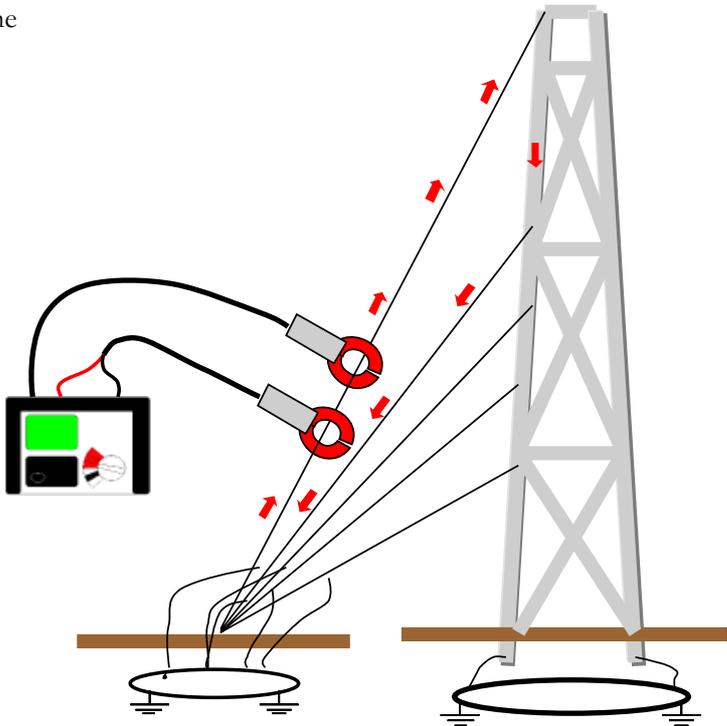
able to measure the earth resistance. Used incorrectly the method may give misleading results.



As can be seen in the above diagram, none of the test current flows through the earth mass. In fact the measurement will be a short circuit.

Another example:

Testing a guy line on a telecoms tower.



As the guy line are all linked together both at the tower metal work and at the anchor point, a loop is formed, and no current flows through the earth

mass. Hence the reading will not be the resistance of the guy line to earth.

The best application of “Stakeless” testing

There are many applications where **Stakeless** testing will work extremely well.

These include:

- **Field of earth / Earth Farms**
- **Pole mounted transformer electrodes**
- **Pole mounted transformer guy line when connected to earth system**
- **Earthing in Sub-station cable cellars**
 - It is often impossible to drive in test stakes so this is an ideal application for Stakeless measurements.
- **Single guy lines on towers**
- **Lightning protection electrodes**

With a good understanding **'ART'** and **'Stakeless'** testing will be invaluable tools, saving both time and trouble.

Further information regarding Megger's range of earth testers and their applications may be found at www.megger.com/det