

APPLICATION NOTE

RE>Act™

Re-activate accurate and safe
DC insulation test

Megger®



**DC Insulation Testing
RE>Act™ test mode**

Introduction

The new RE>Act™ test mode is a patent applied for method to warn and indicate the level of impact any re-absorption or depolarisation current from previous insulation tests or any other external DC currents will have on the following insulation tests.

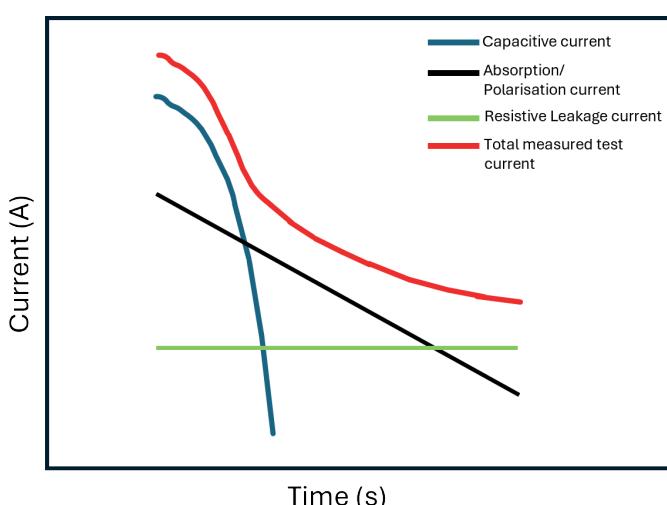
The idea behind this exciting new feature is to provide better accuracy for DC IR results to our customers. This is achieved by allowing our users to view the value of the current present on the instrument terminals before the test as well as after the test is completed and showing the range of values that the instrument is confident in reporting correctly, at the present level of the depolarisation current.

The ability to see the value of the standing current or the residual current in real-time makes it immediately obvious as to what level of error can be expected from the following test, allowing the users to have an accurate and reliable measurement while doing their tests.

Why is it important to discharge your asset after test?

When a test voltage is applied to insulation to measure its resistance, a test current flows. This total measured test current is made up of three main components:

- A relatively quick decaying capacitive current
- A fairly constant resistive leakage current
- A slow decaying absorption or sometimes referred to as polarisation current. The polarisation current is caused by a whole range of polarisation effects of the electric dipoles in the dielectric material in response to the applied test voltage. Some of these polarisation processes are very slow and hence it takes long time also to discharge, even if the voltage across the insulation is short-circuited to be zero.



Separated curves for the three components of the polarisation curve

Using RE>Act™

When an insulation test has stopped and the test voltage is switched off, the insulation material will start to depolarise. This causes a depolarisation current to flow in the opposite direction to the polarisation current. Note that in this case, it is the material-under-test that is the source of current, so the current becomes negative. If a subsequent insulation test is carried out while the decaying depolarisation current is still flowing, the instrument's test current will be reduced by the opposing depolarisation current. This will affect the measurement and result in a much higher measured insulation resistance than the actual value. Equally if the polarity of the next insulation resistance test is reversed than the previous one, then these two currents can add up, and the apparent measured value can be much lower than the actual insulation resistance value.

The test standard IEEE43 suggests discharging the insulation up to four times the duration of the last test, which could mean that if the insulation was tested for 1.5 hours, it is suggested to be discharged for 6 hours.

IEEE95 warns that the danger from previously charged or pre-polarised insulation can exist for indeterminate amount of time, and therefore it recommends at least 2 hours or four times the direct-voltage test duration, whichever is greater. This could take up a lot of time and possibly cause delays or inaccurate results if not discharge properly, especially where repeated measurements are necessary.

How can RE>Act™ help save time while providing reliable measurements?

The IEEE recommend at least four times the test time to discharge before attempting the next test (see below). This will be a worst-case scenario, as the IEEE will be assuming no method to know when the insulation truly is discharged. RE>Act™ provides a unique solution to this issue, visualising in real time the discharge process, meaning that the operator will need to wait only the time it takes for the required measurement scale to be unblocked. This can potentially saving hours of otherwise unnecessary and unproductive waiting.

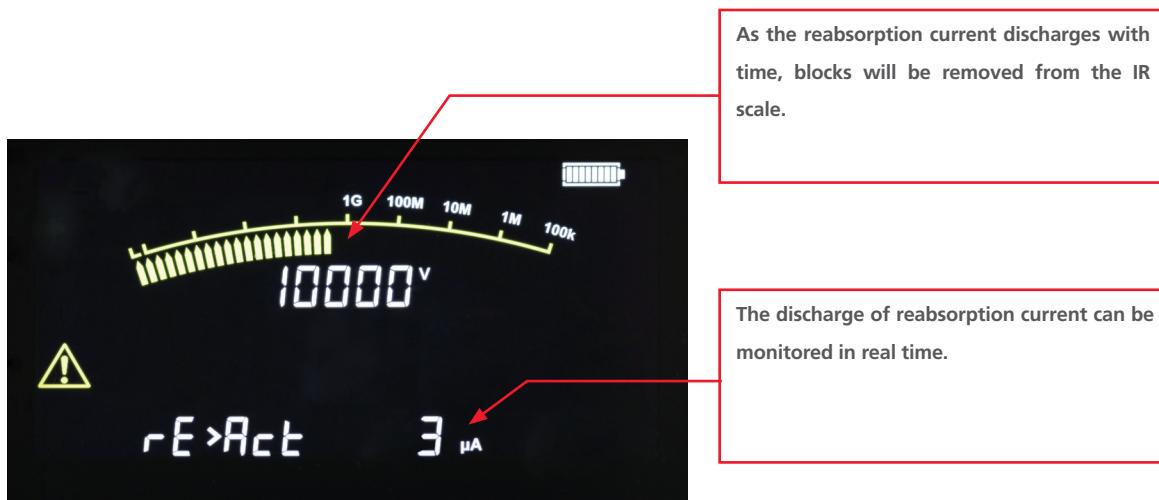
The RE>Act™ mode (short for Re-Absorption Current Test) available on the new MIT and S1 Mk2 keeps measuring the current incoming to the instrument even after the applied voltage becomes zero. This lets the users monitor the current present on the asset in real-time, giving a clear indication of the standing current on the asset and how it will affect their next test.

The RE>Act™ test mode is enabled by pressing the TEST button momentarily (holding down the TEST button for more than 3 seconds starts a normal insulation test) either before or after an insulation test is performed. The RE>Act™ test screen looks as follows:

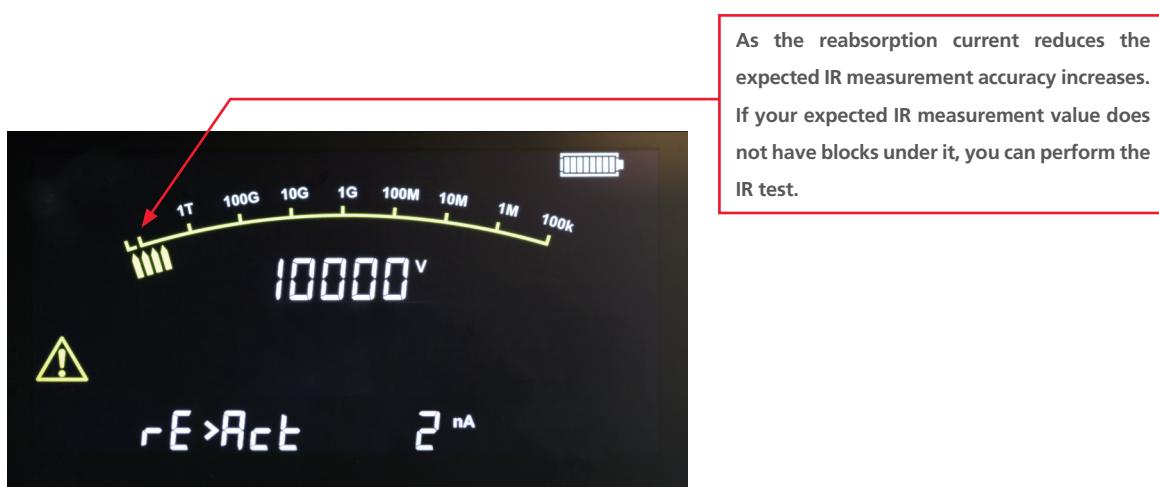


RE>Act™ saves time

After a while the reabsorption current will reduce as it discharges:

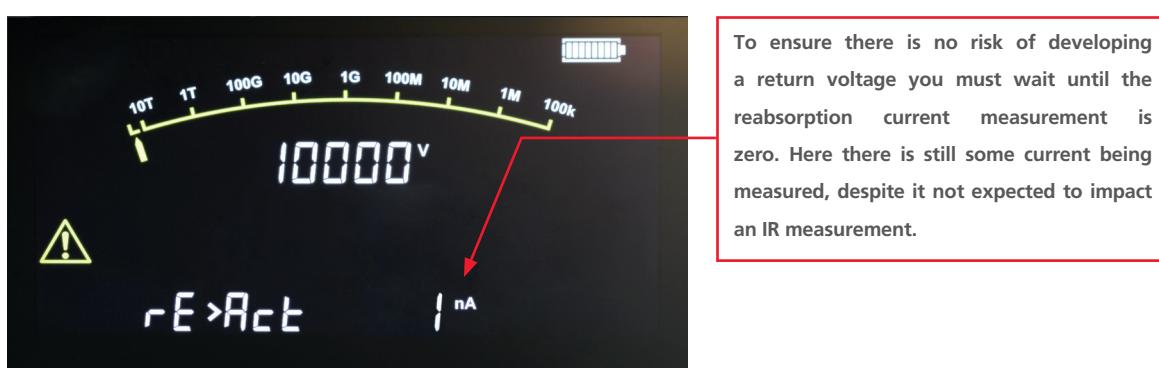


The accuracy of the IR measurement increases as the reabsorption current discharges. This is indicated by the reduction in the number of blocks on the analogue IR scale, as below:



As a rule of thumb any part of the analogue scale which shows blocks means that IR measurements in this area will have a minimum of 10% additional error, but this can easily exceed 100%, as dictated by the physics of the still-present reabsorption current.

Finally, when the reabsorption current is almost completely discharged, the blocks on the scale reduce to 1, indicating that the reabsorption current will have negligible impact on the IR measurement (shown in image below):



Practical examples where RE>Act™ would be useful

More detailed explanation on how the RE>Act™ test mode operates on the instrument can be found in the MIT and S1 Mk2 instrument user guides.

To view the User Guides please click on or scan the QR code:



How can RE>Act™ enhance safety?

Measurement accuracy can clearly have a direct effect on safety. Reabsorption current can result in either higher or lower insulation resistance measurements, depending on polarity. So, imagine the impact of this:

■ Measurements too high

- **Poor insulation could pass inspection when it shouldn't have.**
- **Poor insulation can cause fires, catastrophic equipment failure or even electrocution.**

■ Measurements too low

- **Good insulation could be failed when it is fine.**
- **Safety critical equipment may be taken out of service for no reason.**
- **Incorrect value of DAR or Polarisation Index measured**

Then there is the hazard of reabsorption current itself. If not fully discharged this can turn into a hazardous return voltage. This is where the insulation effectively recharges itself resulting in potentially dangerous voltage reappearing slowly on the connections, despite quickly discharging this voltage to zero after test. RE>Act™ means that the user can monitor the discharge process in real time.



Remember the chance of a return voltage only goes away when the reabsorption current has completely gone. In other words, the measurement is zero. The required international and national safety procedures should be always followed, such as leaving the ground connected across the insulation, when not in use.

RE>Act™ improves safety

Aside from safety implications of an improper discharge of asset, the results obtained can be completely inaccurate in such scenarios.

Example 1, 1 minute IR spot checks and PI tests

As discussed above, if the material is not properly depolarised from the first test, it will affect the following tests significantly depending on the state to which the material is polarised. This could falsify upwards the results of the spot testing at 60 seconds because with pre-polarised material, the second test would show higher values.

For longer tests such as **Polarisation Index test (PI test)** (usually 10 minutes), the result could be falsified downwards, because value at 60 seconds would be higher and thus the ratio of 10 min to 1 min would be lower, resulting in possibly condemning even the good insulation. Even more complex issues arise if the testing is performed between various phases in a 3-phase system, as the effective polarity might be reversed during such tests (because of the 1-2-3 sequence) and thus the polarisation effects might affect the reading in either direction, unknown to the user.

Example 2, transformer testing

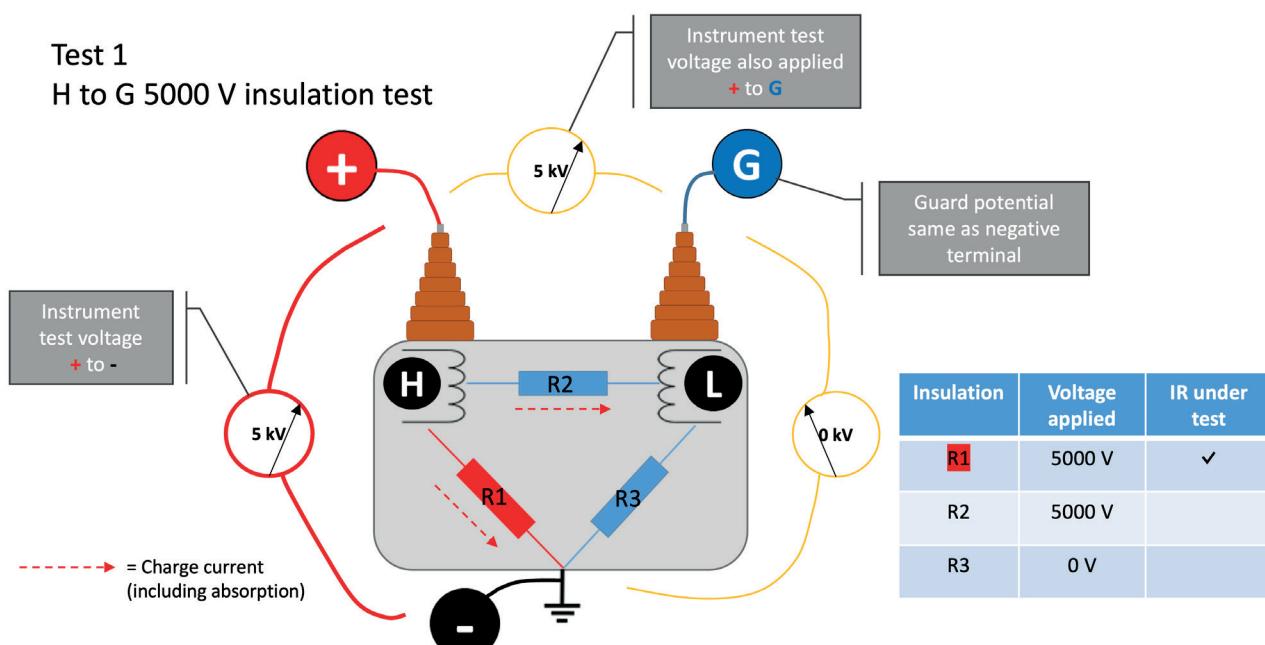
The results could be notably wrong due to the effects of polarisation or absorption, especially if a test is carried out too soon after a previous test, even between testing different insulation.

For instance, when testing a two winding (HV/LV) transformer, there is a sequence of tests performed, usually:

- **Test 1 - H to Ground, L Guarded**
- **Test 2 - H to L, Ground Guarded**
- **Test 3 - L to Ground, H Guarded**

Let's take the first two measurements as an example. Often there is an assumption made that these tests can be performed in quick succession since in each test different insulation is being tested. However, the test voltage is being applied to other insulation, not just that being tested. It's usual for the connection not being tested to be connected to the Guard terminal so that leakage current flowing to the connection can be ignored and removed from that measurement. However, the Guard terminal is at the same potential to the negative terminal so the test voltage will be also applied between the positive and the Guard terminal, thereby charging that insulation too.

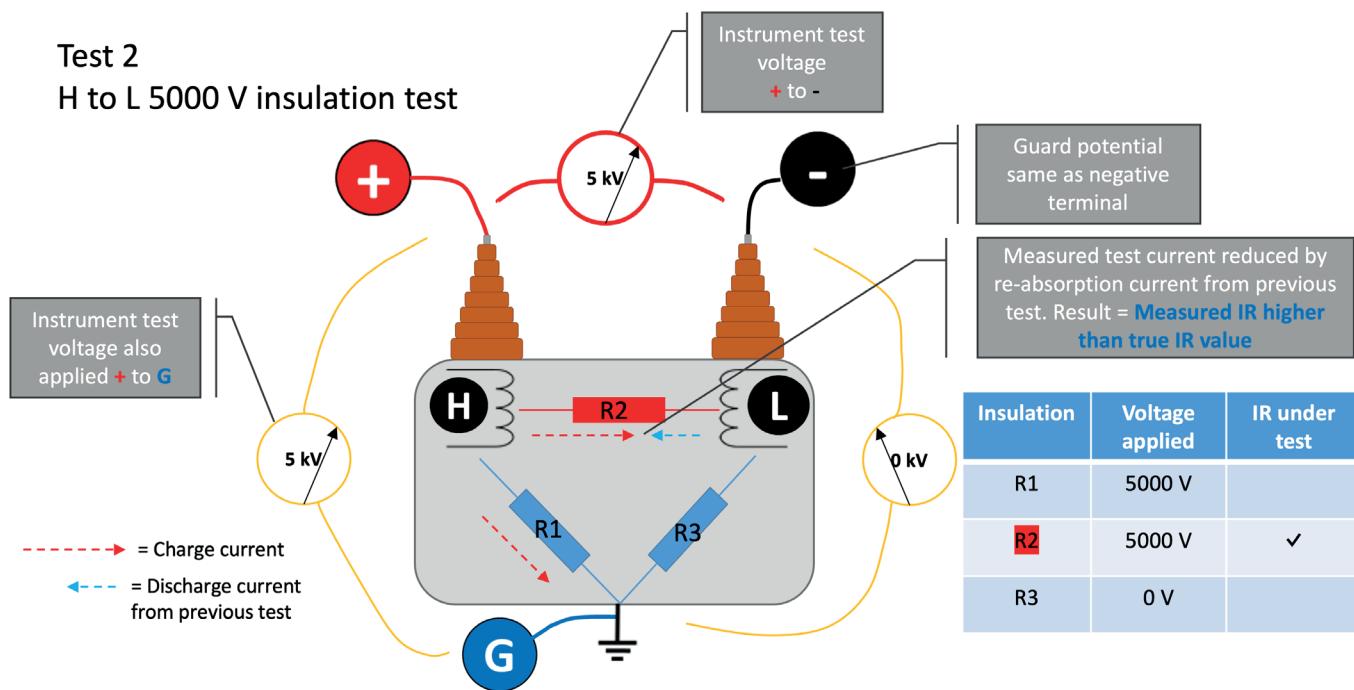
This can be seen in the diagram below:



Practical examples where RE>Act™ would be useful

In this example the insulation being tested is between High winding and Ground, represented by R1. Since the Guard terminal is connected to the Low winding, the test voltage is also being applied between the High winding and the Low winding with the insulation represented by R2. This means that during this test R2 is also being charged in terms of both capacitive and absorption current.

Test 2 in this example is to next test between the High and Low windings as represented in the diagram below:



In Test 2, the insulation between the High and Low windings has the test voltage applied in the same polarity as the test voltage applied during Test 1, represented by R2. If the R2 insulation was not properly discharged before Test 2, a reabsorption current will be still flowing from Test 1 which will flow in the opposite direction to that of the Test 2 test current. This will result in the test current being measured much lower than it should be, which in turn means the IR measurement will be much higher than it should be. The end test result reporting the insulation resistance to be much higher than it is.

The operator could potentially pass insulation which should have failed. This could have safety implications.

This is why the IEEE recommend the long discharge times between measurements. However, the IEEE recommendations are worse case timings, using RE>Act™ could potentially speed up these waiting to discharge times by monitoring the reabsorption currents allowing the user to exactly know when it is safe to commence the next test.

In addition, the other concern is "return voltage". There is an assumption that when the discharge voltage measurement drops to zero, that the insulation has been safely discharged, however that will only be the capacitive element of the discharge. The reabsorption of the insulation may not have completely discharged. The much lower reabsorption current may continue for some time, meaning if it is not properly discharged a hazardous return voltage may appear.

Practical examples where RE>Act™ would be useful

Example 3, cable testing

As with transformer testing, insulation resistance test results can be notably high or low compared to the true insulation resistance due to the effects of reabsorption current or other DC currents flowing in the insulation. Again, RE>Act™ resolves these issues by allowing the user to measure any current and monitor when it is safe to proceed with the insulation test.

There are a number of tests performed on multicore cables and care must be taken to ensure insulation is fully discharged before starting the next test. One core does not mean other insulation within the cable was not charged. It should be noted that long cables can represent high capacitance, which can make the repolarisation current to persist for a very long time (hours).

In this example a three-core cable is under test, and typically the following tests would be performed:

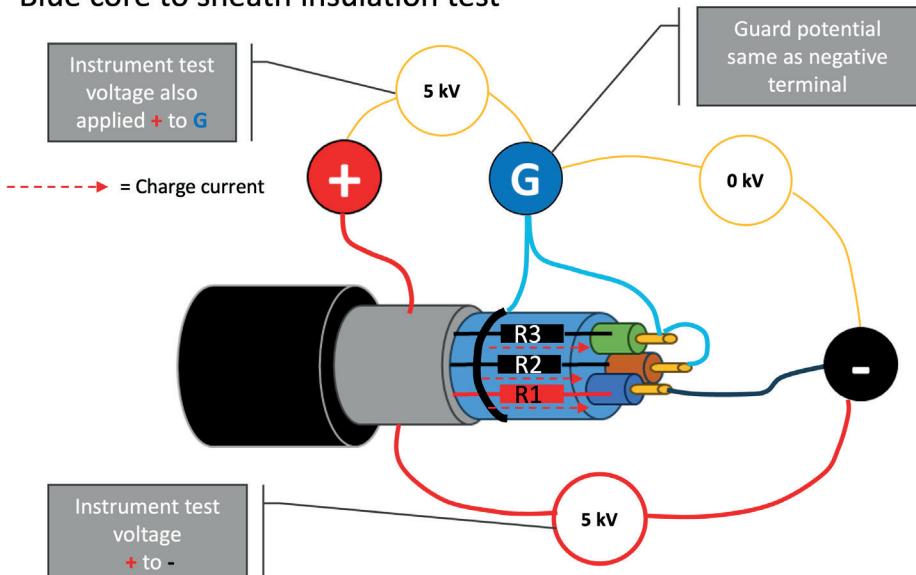
- **Core 1 to sheath**
- **Core 2 to sheath**
- **Core 3 to sheath**
- **Core 1 to core 2**
- **Core 1 to core 3**
- **Core 2 to core 3**

However, note that the cores not being tested would be connected to the guard terminal, to ensure only the current flowing in the insulation under test is measured by the insulation tester. The same as when testing transformers, that means even the insulation that is not being tested directly has the test voltage applied to it, and is therefore being charged.

In this example we will review only the first two tests, and demonstrate where the instruments test voltage is being applied and what insulation is being charged:

Test 1

Blue core to sheath insulation test



Insulation	Voltage applied	IR under test
R1	5000 V	✓
R2	5000 V	
R3	5000 V	

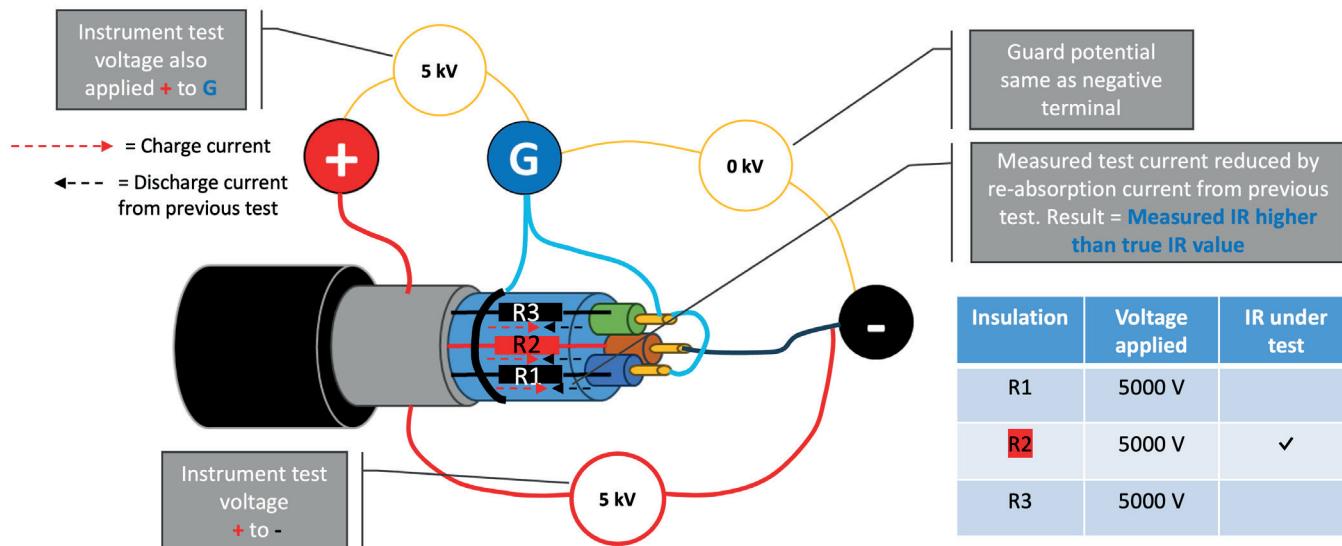
As can be seen, although the only insulation being tested directly is represented by R1 the test voltage is also being applied to R2 and R3, they are being charged, and an absorption current is flowing.

Practical examples where RE>Act™ would be useful

In the next test it can be seen that a reabsorption current is flowing on all the core insulation, that must be discharged enough before the next test is applied:

Test 2

Brown core to sheath insulation test



Again, care must also be taken that the reabsorption current is fully discharged to prevent a return voltage hazard. Please note that after a test the voltage measurement will only indicate that the capacitance has been discharged. Only the RE>Act™ test mode can monitor the reabsorption current.

Conclusion

It should be remembered that the capacitive current represents different phenomenon from the absorption current. Therefore, the discharge mechanism for these two processes is also very different, quick for the capacitive current but very slow for the reabsorption current.

Generally, it is accepted that insulation should be discharged at least for four times the duration of the last test before attempting another to ensure reabsorption current is not going to affect the next test. However, monitoring the discharge with RE>Act™ can often greatly reduce that time.

If the insulation material is not properly depolarised from the first test, then any subsequent test can be significantly affected by the state to which the material was polarised. RE>Act™ gives the users the ability to see the amount of the standing current or the residual current in real-time making it immediately obvious as to what level of error can be expected from the next test, allowing the users to have an accurate and reliable measurements.

Key benefits of RE>Act™ summarised

■ Enhanced safety

- Prevent the passing of potentially poor insulation.
- Ensure there is no chance of return voltage.

■ Enhance measurement accuracy.

■ Save time – Reduces the time to discharge after the test is complete.

■ RE>Act™ works with other Megger patented time-saving patented methods such as PI Predictor™.

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