SANS 10142-1 and the bonding test

By Anthony Schewitz, ECA Technical Adviser

One of the significant changes in SANS 10142-1 Edition 3 is the bonding test (clause 8.6.2), however many electricians are still unaware that this test has been completely revised; unless, of course, they've attended the ECA's CoC Refresher course or the SANS 10142-1 Updates course.

Before we get into the actual test and how it is conducted, let's look at some basic knowledge of the History, the information that's required and see how the new way of testing has evolved.

History

In the past, testing was rather different … most of the electricians from the pre-1992 era will tell you that an inspector from the council conducted what was commonly referred to as the "bell test". The inspector used a battery connected to a buzzer and would touch various accessible conductive points in the installation with the test leads. When the buzzer sounded, the tester knew there was continuity between the different parts and the installation had been done correctly and that the measurement was below the required value, based on the Ohm's Law calculation.

Later, the test was conducted using instruments such as the AVO meter and insulation resistance meters. Interestingly, AVOmeter is a British trademark for a line of multimeters and electrical measuring instruments (the brand is now owned by the Megger Group Limited). More interesting is that it's often called an AVO, because the company logo carries the first letters of 'amps', 'volts' and 'ohms'.

In the 1940s and all the way through to the 1969 revision of the code of practice, there is no mention of the test as we know it today. In those days, only the path back to the main earth terminal was tested. The test was commonly referred to in the various municipality's 'laws and practice documents', however, as quoted from page 123 in the 1969 revision (below) the requirements documented in the 'Blue Book' (or the South African Institute of Electrical Engineering: Standard Regulations for the Wiring of Premises) and the requirements were straightforward:

> ***1410. TESTING OF EARTH-CONTINUITY PATH***
> *A test shall be made to verify that the resistance of the earth-continuity path does not exceed the maximum value specified in Regulation 1302 (E).*

From 1976 onwards, the test was a combination of the both earthing and bonding verification with no difference in the test method, as quoted hereunder:

> ***SABS 0142-1981 Page 86***
> ***9.3.2 Earth and Bonding Continuity***
> *Use the following procedure to verify that the resistance of the earth continuity path does not exceed the appropriate value given in Table 2:*
> *a) For values in Column 1 not exceeding 63 A, measure the resistance between the consumer's earth terminal and any exposed conductive part of the installation or any other conductive part that is required to be bonded to the earth continuity conductor in terms of the code;*
> *b) for values in Column 1 exceeding 63 A, determine the resistance by calculation or by measurement (as in (a) above).*

From the publication of SABS 0142: 1993 Clause 8.7.2 as quoted below, the requirements stayed relatively the same and later, as can be noted in clause 8.6.2 of SANS 10142-1 Edition 2 in 2017, the separation of the two tests was continued with a very similar testing methodology.

> ***SABS 0142-1 Ed 1 Page 253***
> ***8.7.2 Continuity of bonding conductors***
> *Test the continuity of the bonding conductors between the consumer's earth terminal and all exposed conductive parts using a supply that has a no-load d.c. or a.c. voltage of 4 V to 24 V, and a current of at least 0,2 A. In each case, the resistance shall not exceed 0,2 Ω.*

In the International Electrotechnical Commission's (IEC) international standard for electrical installations for Buildings, IEC 60364-6: 2016 clause 6.4.1, the method used is closer to the older specifications that effectively keep four tests under one heading (which probably helps weed out any confusion on the matter).

> ***IEC 60364-6:2016 page 10***
> ***6.4.3.2 Continuity of conductors***
> *The continuity of conductors and connection to exposed-conductive-parts, if any, shall be verified by a measurement of resistance on:*
> *a) protective conductors, including protective bonding conductors,*
> *b) exposed-conductive-parts, and*
> *c) in the case of ring final circuits, live conductors.*
> *NOTE See also Annex A.*

Looking at the theory that was used over the last 20 or so years, we can see that the method used for the test was not entirely based on the definition of bonding, but that it rather repeated the method to test the earth path back to the main earth bar, which in the current and previous standards as per the requirements of clause 8.6.3 of SANS 10142-1.

Groundwork

When students are asked in training sessions whether bonding and earthing is the same thing, most answer with a 'yes' but there is a vast difference in the principles and methods of protection. Bonding and earthing only share a common method of construction but are different in operation, requirements and purpose – and these are made clear when we read the definitions purporting the specific uses of their conductors in SANS 10142-1.

The definitions in the standard are:

> ***3.14.2 bonding conductor***
> *conductor, including any clamp or terminal, that connects together exposed conductive parts (see 3.13.1), extraneous conductive parts (see 3.13.2) or both exposed and extraneous conductive parts, with the object of bringing such parts to the same electrical potential*
>
> **3.14.4 earth continuity conductor**
> *earthing conductor*
> *conductor, including any clamp or terminal, that connects the consumer's earth terminal to the exposed conductive parts of an installation for the purpose of earthing such parts and carrying fault currents*

It is very important to note that bonding is to bring two simultaneously accessible conductive parts to the same electrical potential, much like a busbar brings all the conductors attached to it to the same electrical potential that, in the case of a busbar, is phase voltage.

In our practice when we refer to bonding in the safety standards, we are commonly referring to earth-bonding that, in the simplest form, means we are checking if things are the same potential and that this potential should be the same as earth.

By that very basic theory, and when we look at the old way the test was conducted, it seems to be a duplication of the Resistance of Earth Continuity Conductors Test clause 8.6.3 as opposed to a verification of similar potential.

How the current test has changed and is conducted.

Edition 2 of SANS 10142-1:2017, clause 8.6.2 below, states that the bonding between the consumer's earth terminal and accessible conductive parts must be verified. This test requires a long lead to verify the return path of the earth back to the distribution board.

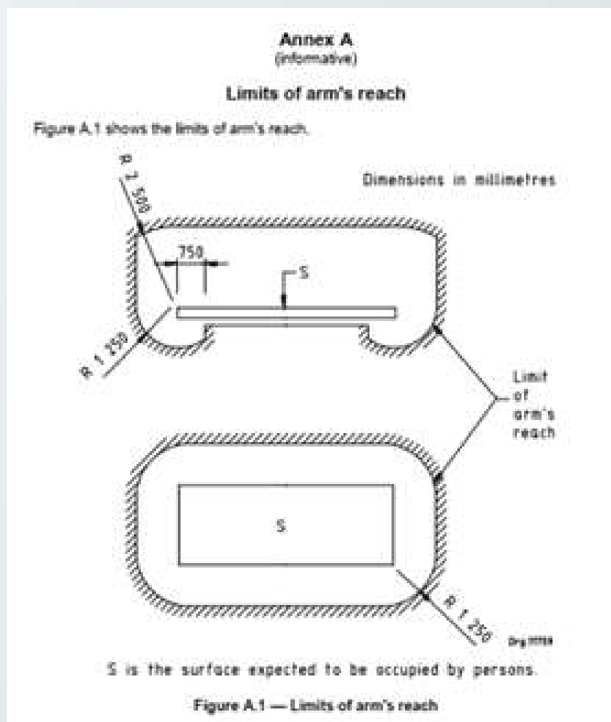
> ***8.6.2 Continuity of bonding***
> *Test the continuity of the bonding between the consumer's earth terminal and all exposed conductive parts using a supply that has a no-load d.c. or a.c. voltage of 4 V to 24 V, and a current of at least 0,2 A. In each case, the resistance shall not exceed 0,2 Ω.*

Edition 3 of SANS 10142-1 refers to parts within arm's reach that, in layman's terms, means anything a person can touch or come in contact with within arm's reach.

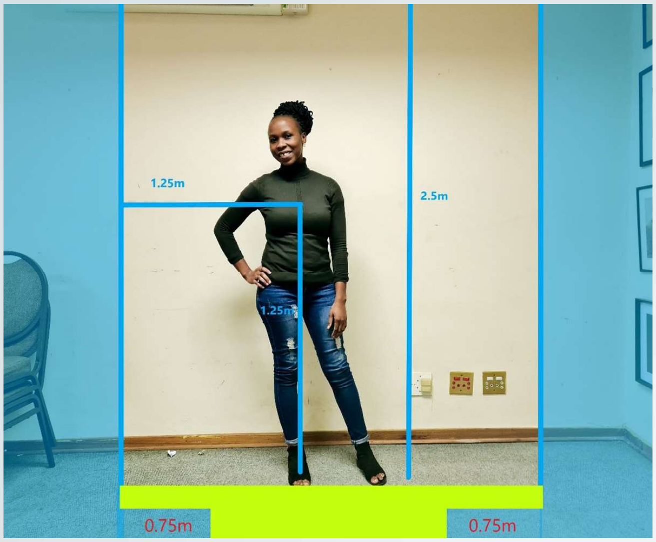
> **8.6.2 Continuity of bonding**
> *Confirm the continuity of the bonding conductors between all exposed conductive parts within arm's reach (or see annex A) of each other. When a test device is used, it shall have a supply that has a no-load d.c. or a.c. voltage of 4 V to 24 V, and a current of at least 0,2 A. In each case, the resistance shall not exceed 0,2 Ω.*

The main difference between the two clauses is simply the method of testing and, to understand this, we must look at the definitions and how the new test is carried out.
That main change involves the arm's reach situation, which is made clearer when we look at the definition and the image in ANNEX A below.

3.4 Arm's reach
volume that is limited by the relevant of the following distances measured from a surface expected to be occupied by persons (see annex A):
a) 2,5 m vertically upwards;
b) 1,25 m vertically downwards from the outer edge of the surface;
c) 1,25 m horizontally outwards from the outer edges of the surface; and
d) 0,75 m horizontally inwards from the outer edges of the surface and underneath the surface



The interpretation of arm's reach is key in this test. The minimum legal limits of what is considered to be within arm's reach and which would

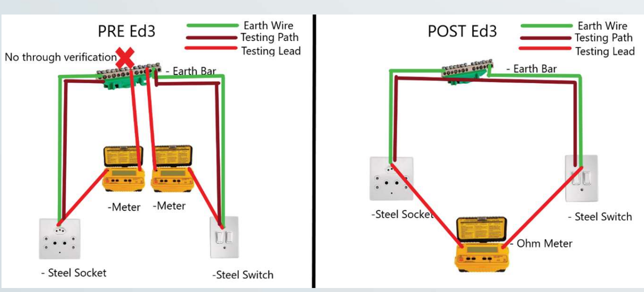


have to be tested, is illustrated in the following image of the ECA's Highveld administrative clerk, Pfano Nemakonde. She is standing in an unshaded 'bubble', which indicates the area that would be considered to be within immediate arm's reach on this plane for her (keeping in mind that arm's reach would be three dimensional and the additional horizonal limits considered making a cube around her). Everything outside the blue 'bubble' would be considered outside of her sphere of influence, that is, out of arm's reach.

As can be noted you would need to test between the sockets themselves and the air conditioner (if accessible conductive parts are present) and ensure the reading remains below 0.2 Ohms. If not, you may have to check terminations or ensure there is a bonding conductor installed between the two points where the high reading is recorded. The yellow/green shading illustrates that, if she were standing on a platform, we would also see the spaces under the platform as a limit of arm's reach (this aspect is very important when testing in areas such as a high-rise building, etc, where there may be parts that are accessible by reaching around. Although not very common, ultimately parts that require you to reach over and or reach in do form part of the requirement if they fall within the limits.

Why the new way is safer?

The latest edition 3 test report asks for a simple confirmation (correct or not) as opposed to a value which was the norm in previous reports. This change on the report is due to the applicability and eligibility of the basic 'bell test', which does not give a value but notifies if correct. You would have to verify all the accessible parts with the test and verify whether they all are correct, and then noting that these are correct.



Looking at the two examples of the tests being conducted (above), you will notice the new test suits the definition a lot more closely than before as you are verifying the loop through the earth bar and ensuring that there is minimal resistance between the two accessible parts. That is, they will be at the same electrical potential due to the low resistance between the two and because your bonding is of earth potential, it means that you have verified that they are connected and connected to the earth.

SANS 10142-1 8.6.2 states that we must use a device with a specified voltage and current output to verify that the resistance remains below 0.2Ohms when verifying bonding. If satisfactory conditions have not been achieved, then additional bonding conductors may be required.

It is very important to remember that the old test basically does verify part of the new test. The only reason that I stated the new way as being "safer" is based on the words 'through verification' where we are testing based on the definitions and verifying whether things are, in fact, the same potential.

When the readings are not correct

If the 0.2 Ohms or the bus test fails, then it is a clear indication that additional bonding is required in the installation as there may be a potential difference between the two accessible conductive parts. This means there will be more parallel paths back to the DB, in turn making the earthing system more efficient, that is there are more paths down to ground for faults to dissipate and hence safer.

Conclusion

Although the change is quite significant, it is a better method of verifying the bonding of the installation than was done before. Bonding is crucial because when it is correctly done, it can be tested and visually verified, making the tester and/or user more confident that they are protected. The new test covers more of the installation than the previous test (if applied correctly) and it protects what your client can touch as a first line of defence.

It must be noted that the old way of testing is not wrong. The new test will probably have some teething issues when it comes to interpretation and implementation but looking at the theory, it is a different application that could alleviate problems with testing and clarity the results.

It is my belief that if this is carried out correctly, it would result in better earthed premises and more cross-bonding between devices, which were not normally bonded as the image above shows.

There may be times where there will be no bonding test required and there may be times when there is more than one. In a typical house, the difference wouldn't really be noticed but in larger installations, I believe this method of testing is going to add a great deal to the bottom line.

You will always have items that you will have to bond in accordance with SANS 10142-1 Edition 3. If you have used the correct methodology, you can be assured that the installation is safe.

More info: **Anthony Schewitz on (010) 271 0686**
Email: **anthony@ecasa.co.za**