Understanding the new neutral loop impedance test in SANS 10142-1 Edition 3

By Anthony Schewitz, ECA Technical Adviser

The new requirements for the verification of neutral loop impedance (NLI) published in SANS 10142-1:2020 (Edition 3) mean that electrical contractors will now have to use a different NLI test when completing certificates of compliance. This article seeks to answer the typical questions received by the ECA since the new test report was published in July 2020 and the hard copy CoC became available during August 2020. These include: "*How do I conduct the new NLI?*" and "*Do I have to get a new meter to do this test so that my installation conforms with the new requirements?*"

Before 1992, utilities had to 'co-sign' on completion of installation work using the F37 form, and the verification of the quality and safety of the electricity was the responsibility of the council. However, since the publication of the Electrical Installation Regulations of 1992 and the amendment of the safety standard, SABS 0142-1:1993, the responsibility for verifying the utility's network in an electrical installation has been put into the hands of the Registered Person.

In SANS 10142-1 Edition 3 (2020) there are six tests that are currently conducted to ascertain and verify the quality and safety of the electricity to premises/buildings, and these include:

- Prospective short-circuit current (PSCC)
- Earth Loop Impedance
- Neutral Loop Impedance
- Supply Voltage no load
- Supply Voltage on Load
- Phase rotation

In some instances, this may seem unfair as sometimes supply authorities may take some time to rectify faults, and this can delay the issuing of certificates of compliance by the electrical contractor. However, it must be remembered that certification and verification are part of the electrical contractors' scope. Hence, if there is a fault on the upstream network, it could affect the safety of the occupants using the installation – and safety is at the core of the OHS Act.

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8.6.5 Earth and neutral fault loop impedance at the main switch

8.6.5.1 At the main switch, the earth loop impedance shall be such that an earth fault current double the rated current (or higher) of the main protective device automatically disconnects the supply to the installation. Table 8.2 indicates the earth fault loop circuits for different distribution systems.

8.6.5.2 Where a Neutral conductor is provided, test the Neutral loop impedance for all low voltage distribution systems.

NOTE 1 For this test using the same instrument as per 8.6.5.1, both the neutral and earth clamps of the instrument will be connected onto the neutral conductor.

NOTE 2 To carry out this test, where possible switch off the main switch and disconnect the main neutral so as to minimise parallel neutral or earth paths. Connect the test leads to the line side of the supply. The resistance reading should normally be lower than that calculated for the earth loop impedance or be at least substantially the same. At no stage may the Neutral impedance ever be higher than that calculated for the earth conductor

NOTE 3 The introduction of the neutral fault loop impedance test will be implemented six months after the publication of this document.

8.6.5.3 At the main switch, the neutral loop impedance shall be such that the fault current double the rated current (or higher) of the main protective device automatically disconnects the supply to the installation.

8.6.5.4 If, for practical reasons, the requirement in 8.6.5.1 and 8.6.5.2 cannot be complied with, as an alternative, an earth fault detection and disconnecting device may be installed at the supply to the installation. The earth fault detection and disconnecting device should be so installed that it operates at a current related to the earth fault loop impedance which will limit touch voltages to 25 V under short-circuit fault conditions for a period not exceeding 5 s.

How the NLI test is conducted with a typical three-wire PSCC/ Earth Loop Impedance tester

The test can be conducted using the same instrument normally used for earth loop impedance with no modifications other than method used to test.

1. Ensure you are familiar with the type and operation of your instrument and, if in doubt, ask the supplier of the instrument to confirm its operation*
2. Confirm loop impedance with the Calculation Zloop = V/(Icbx2)
3. Connect lead marked E to Main Neutral
4. Connect lead marked N to Main neutral
5. Connect Live Lead to Main incoming Live (Steps 3 -5 are shown in Photo 1.)
6. The Instrument will show if it is safe to continue, usually by means of an indicator on the device.
7. Once safe to continue, press test
8. The instrument will give an ohm reading for the loop impedance indicating the Neutral return path of the transformer and the impedance thereof. This is shown in Photo 2.

*It is important to note that some newer test instruments already have the functionality to test NLI without moving leads. Always consult the instrument manual or manufacturer to ascertain applicability and methodology.

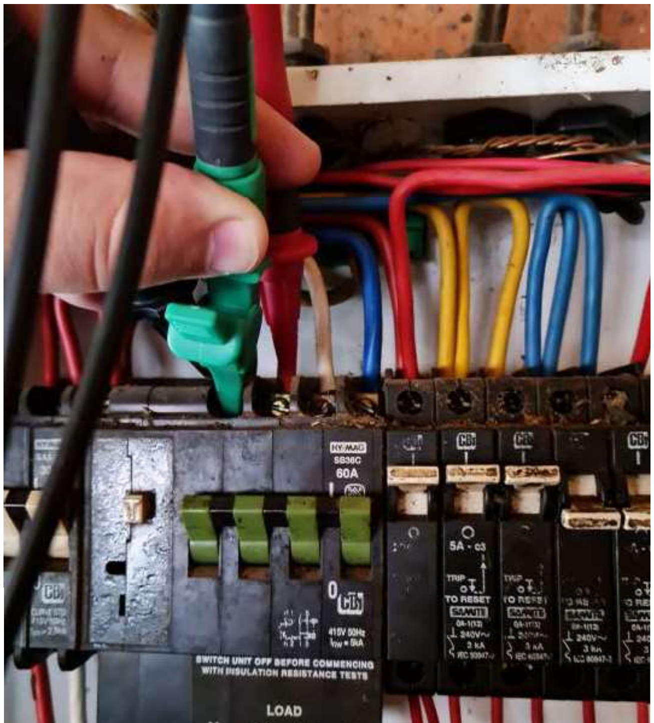

Photo 1: The leads connected to the distribution board.

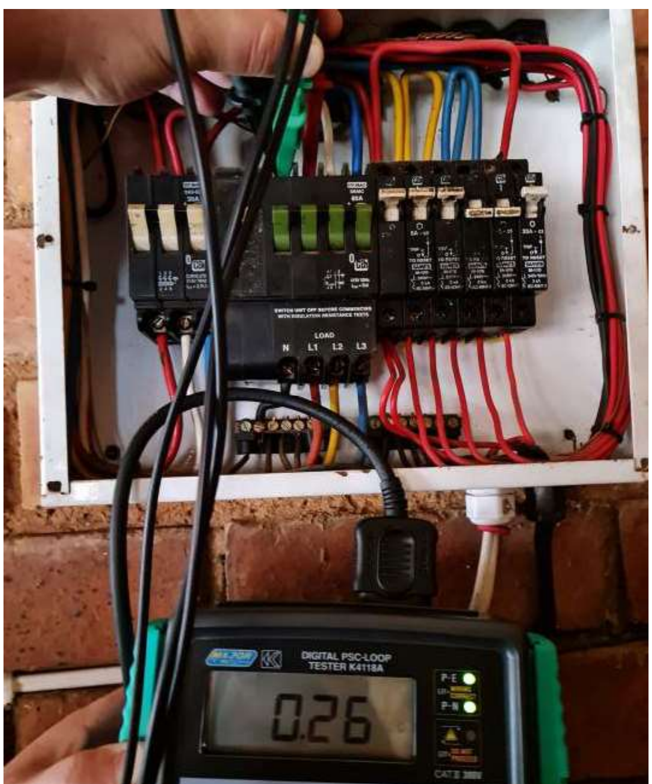

Photo 2: The reading...

What is the maximum reading/ideal readings?

$$Zloop = \frac{V}{2 \times Icb}$$

$$Zloop = \frac{230}{2 \times 63}$$

$$Zloop = 1.83\ Ohms$$

Where:

V	= Voltage between L and N/ E
Zloop	= Maximum allowable loop impedance
Icb	= Main Circuit Breaker in rating
2 x	= Due to the requirement of double the rated current

Using the first principles together with the data mentioned in clauses 8.6.5.1 and 8.6.5.3, you will end up with the above formula, which has always been used to ensure the maximum permissible theoretically calculated value for the loop is determined from the clauses mentioned. This enables verification of the maximum return loop to the transformer between Phase and Neutral or Phase and Earth.

With Earth and Neutral loops, the typical (readings that one should expect) and ideal (preferred readings) readings will always be relatively the same and should always be the same or very close to the same this shows an ideal return path for both conductors that are equal in length and generally connected to the same point.

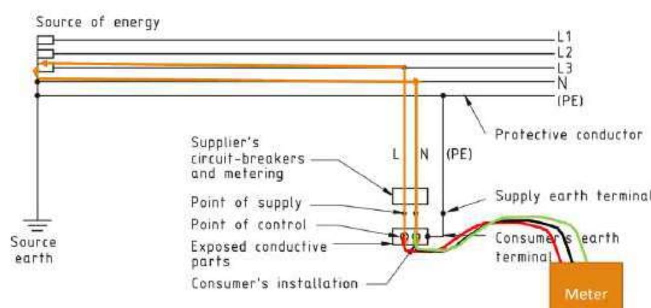

Figure J.2.2 — TN-S system earthing

Using the first principles, one can also calculate the ideal/ expected reading based on the actual values not the theoretical ones based on the information gathered and measured.

For example, if I measure 0.31 ohms on my loop at a voltage of, for example, 235 V then to verify the meter and the reading, the first principles are used to verify the meter and the reading would match the PSCC reading (or at least be lower than the kA of the protective device) this formula would also work to obtain an ideal loop reading if kA is known.

$$Isc = \frac{V}{Zloop}$$

$$Isc = \frac{235}{0.31}$$

$$Isc = 758.065\ Amps\ or\ 0.76kA$$

This principle is followed by most test instruments: Verify the PSCC by measuring the loop and voltage to calculate kA. This can also quickly verify whether the reading produced by the instrument is correct.

What happens when things go wrong?

Tell-tale signs may be **stray voltages** on neutral or earth when body contact resistance is lowered, causing the person to feel a tingle when touching metal parts (such as taps) while washing dishes or showering, for example. When the bonding and earthing is done correctly on the premises and there is no clear evidence of anything being wrong, some typical faults caused are:

Voltages that appear on the earth or neutral conductors due to an increase of impedance in the return path to the transformer; and these voltages typically choose the path of least resistance.

Currents can be evident in neutral and earths with the increase of voltage, which increase the risk of shock for the occupants of the property.

In most cases, earth and neutral on the reticulation side are run as a protective earth and neutral (PEN) so high impedance on either could create an **increased potential** on the protective conductors. This scenario with the PEN in place is typically called a 'floating neutral' which causes 400 V to be supplied to 230 V appliances and consequently cause major damage. Inverters and electronic devices may be **damaged** by stray voltages on earths and neutral, which would typically find a place on electronic devices that does not have suitable insulation to prevent discharge from a neutral or earth channel.

Protective devices may not function correctly in fault conditions due to there being no 'reference' or low impedance path to create the difference in potential.

False readings on test instruments (kA, voltages, etc.).

Conclusion

As per note 3 under clause 8.6.5.2, the test has to be implemented six months after the date that SANS 10142-1 was published. Therefore, it is compulsory to use this test from February 2021.

The electrical contractors who are still using the Edition 2 Certificate of Compliance (four pages) would have to document the NLI test and record the reading that was measured.

It would be in the interests of those contractors still using the four-page CoC to attend an ECA refresher course or to practice this test until he/she understands it.

I hope the guidance provided here has clarified how the test must be done.

The new neutral loop impedance test in SANS 10142-1 Edition 3 is covered in these upcoming ECA courses:

19 May and 17 June	CoC course (for new students)
11 June	SANS 10142-1 Edition 3 course (all updates in SANS 10142-1 Ed 3)
18 June	CoC Refresher course (for registered persons)

To find out more or to book a course, contact Leola Petersen at leola@ecasa.co.za or Phano Nemakonde at pfanon@ecasa.co.za or call the Highveld office on (010) 271 0686.