BOTTER Designs

LOOP, PSC, EARTH TESTERS

WHY and WHERE TO USE THEM?

Simplified Electrical Distribution Network

TRANSFORMER
POWER GENERATION

POWER
DISTRIBUTION

USER'S BUILDING
DOMESTIC OR INDUSTRIAL

- L_3
- L_1
- N
- L_2

Circuit Breaker

User's Socket

- Es
- Ns
- Ls

Main Circuit Breaker
and Earth Leakage
Circuit Breaker
(GFCI)

Earthing Point
of Transformer

Earthing Point
of User
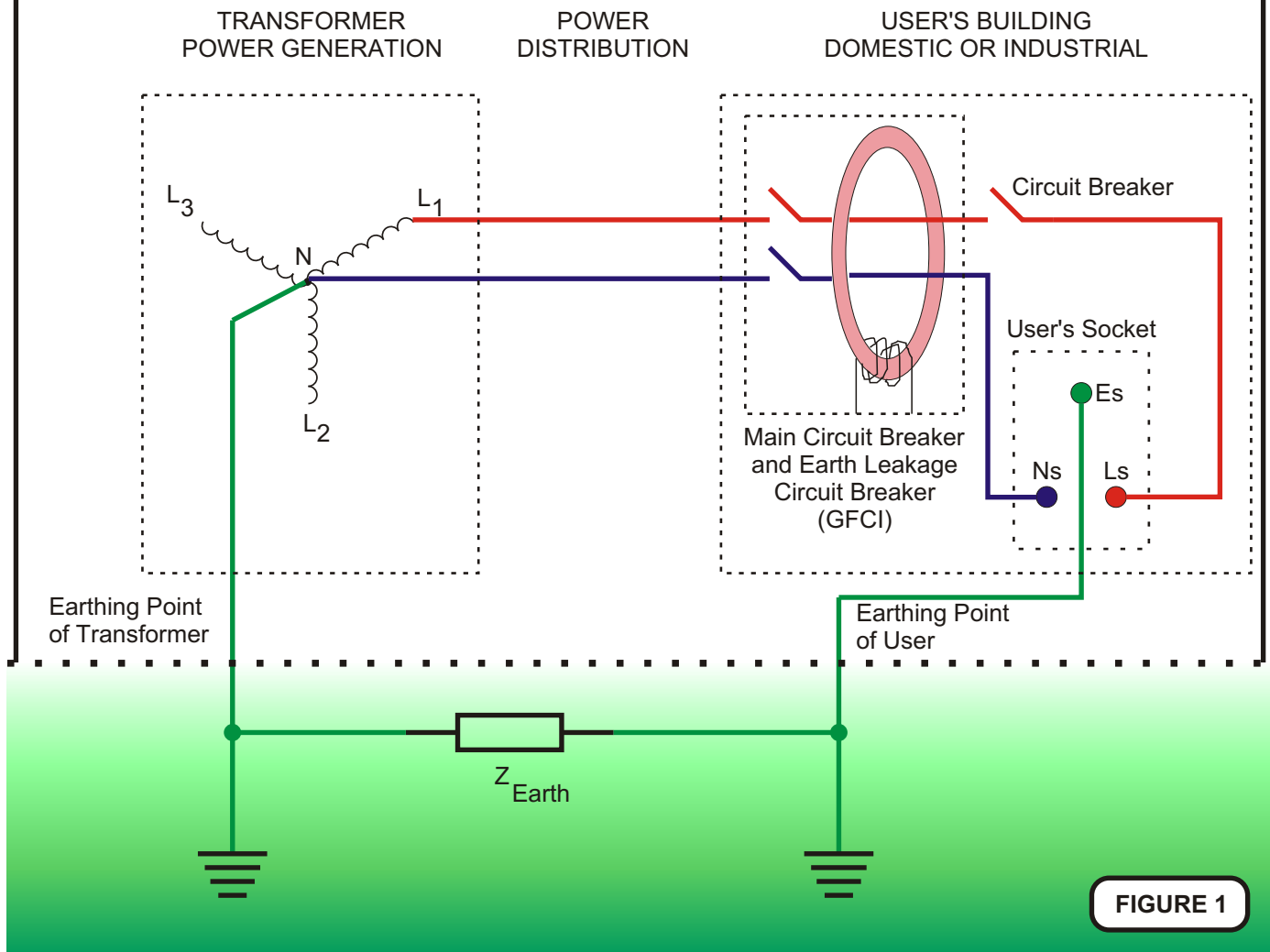
Z_{Earth}

FIGURE 1

- At the power generator, the Neutral point of the transformer is tied to the Earth
  via a cable from N to the Earthing Point of The Transformer (Rod in the Soil) .
- The power is distributed to the user via a cable from the transformer to the user .
- The main Breaker in the user's building break the circuit from the user to the
   transformer (built-in over-load and differential current protection).
- The Circuit Breaker break the individual Live circuit going to the user socket .
- The Socket is wired Es, Ns, Ls
- The Es point is directly wired to the earthing point of the user .

A "Near Real" distribution network need to take into account some others factors .
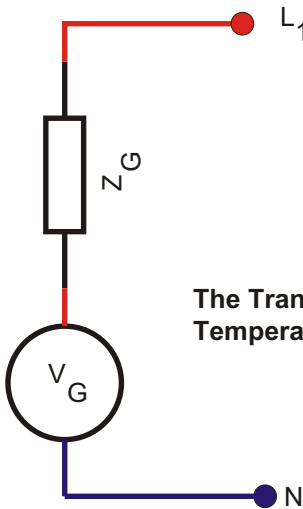To understand it, we will replace the transformer (Power Generator) by the following :

L$_1$

Z$_G$

V$_G$

N

FIGURE 2

Where

Vg	=	The Voltage of the Generator (of the Transformer).
Zg	=	Internal Impedance of the Generator plus the reflected Impedance of the Primary to the secondary of the Transformer .

The Transformer's impedance (Z$_G$) change with current (winding getting warmer), Load, Temperature, Time since maintenance. These changes are of slow moving type.
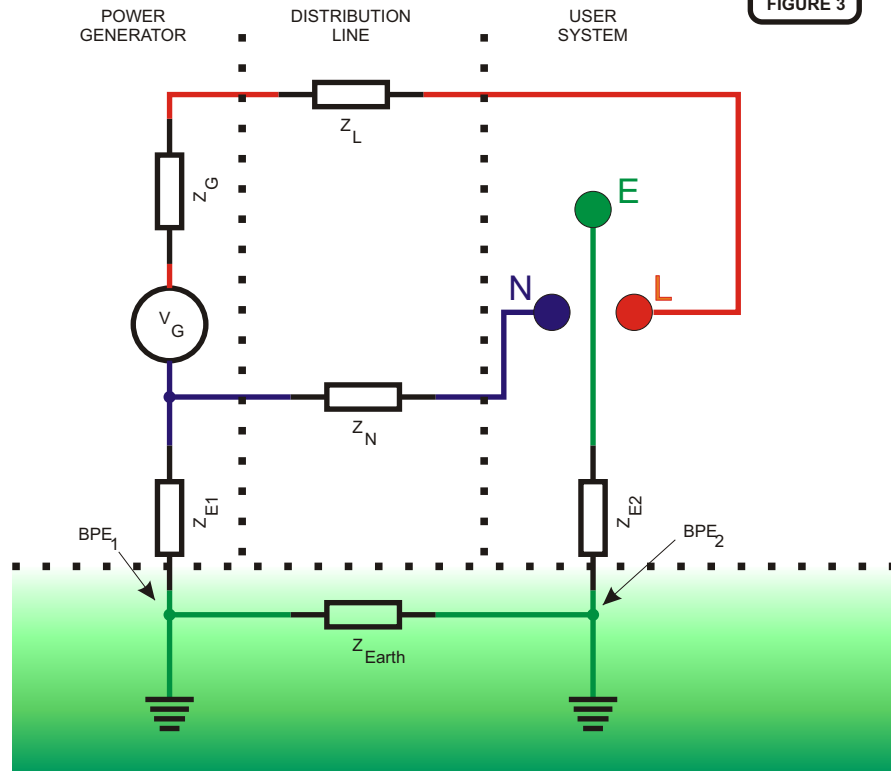
OVERVIEW OF AN ELECTRICAL INSTALLATION

FIGURE 3

POWER GENERATOR   DISTRIBUTION LINE   USER SYSTEM

Z$_L$

Z$_G$

E

N   L

V$_G$

Z$_N$

BPE$_1$ Z$_{E1}$ Z$_{E2}$ BPE$_2$

Z$_{Earth}$

BPE1	=	Bonding Point Earthing "one ".
BPE2	=	Bonding Point Earthing " two ".
ZL	=	Impedance of the LINE wire.
ZN	=	Impedance of the NEUTRAL wire.
ZE1	=	Impedance of the Earthing wire from the Transformer to the BPE1.

Z$_L$ Z$_N$, Z$_E$, etc...are in serie with contacts resistance from connections, circuit breaker, bonding points, In a real electrical system, these impedances are part of the result of a complex electrical network where impedances are added and subtracted dynamically (complexes, serie and/or parallel)according to the load situation.
Temperature changes are slow moving type, contact resistance change can be very fast (re-closure time) screws connection getting loose can also be fast some time.
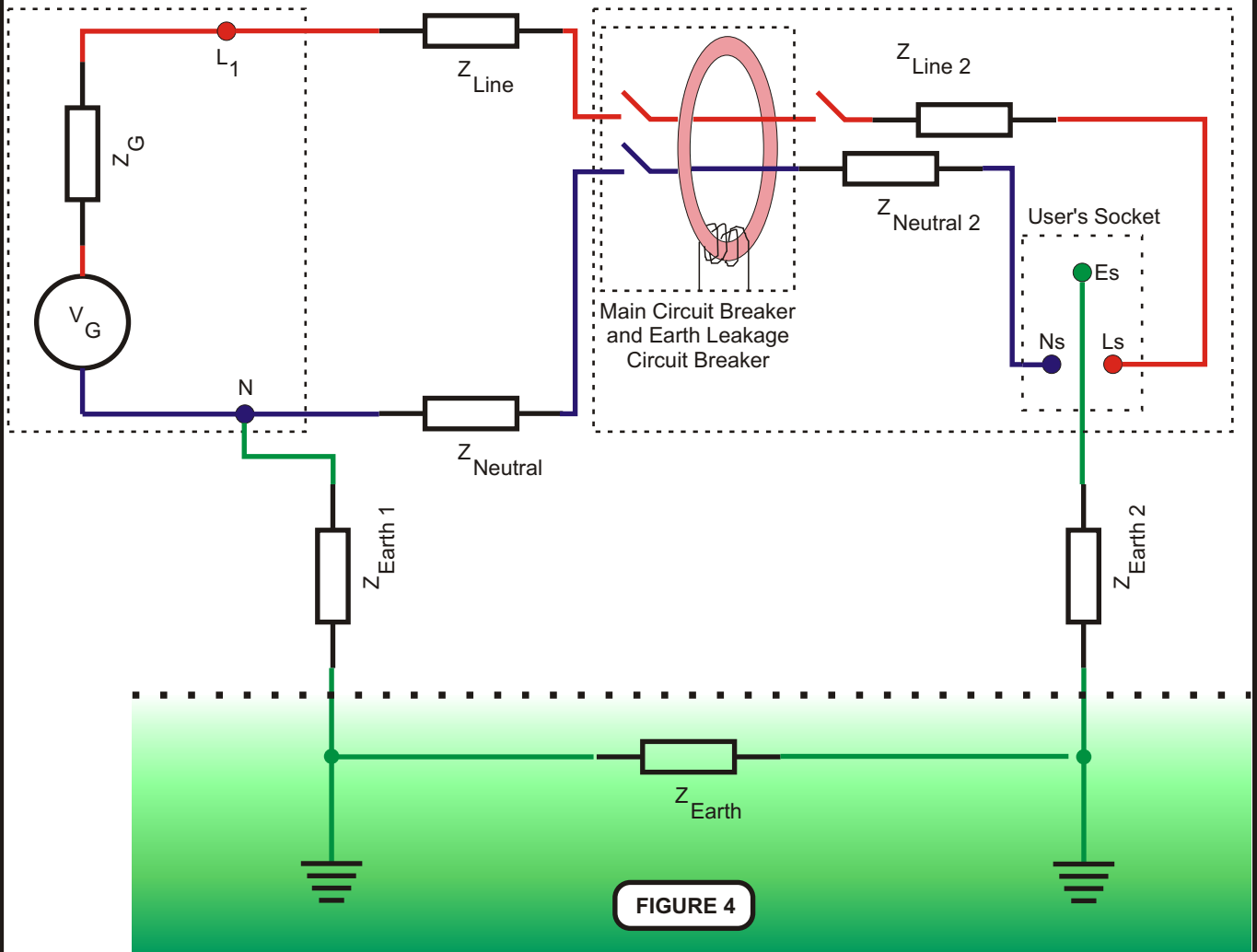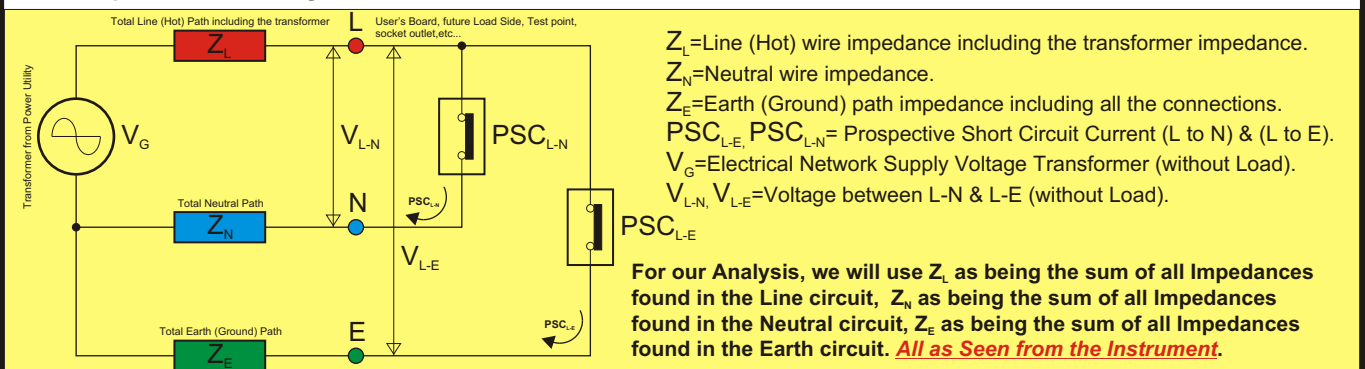
Page 2

TRANSFORMER
POWER GENERATION

POWER
DISTRIBUTION

USER'S BUILDING
DOMESTIC OR INDUSTRIAL

APPLICATION NOTE
by Jacques Botte

21
V1.00

FIGURE 4

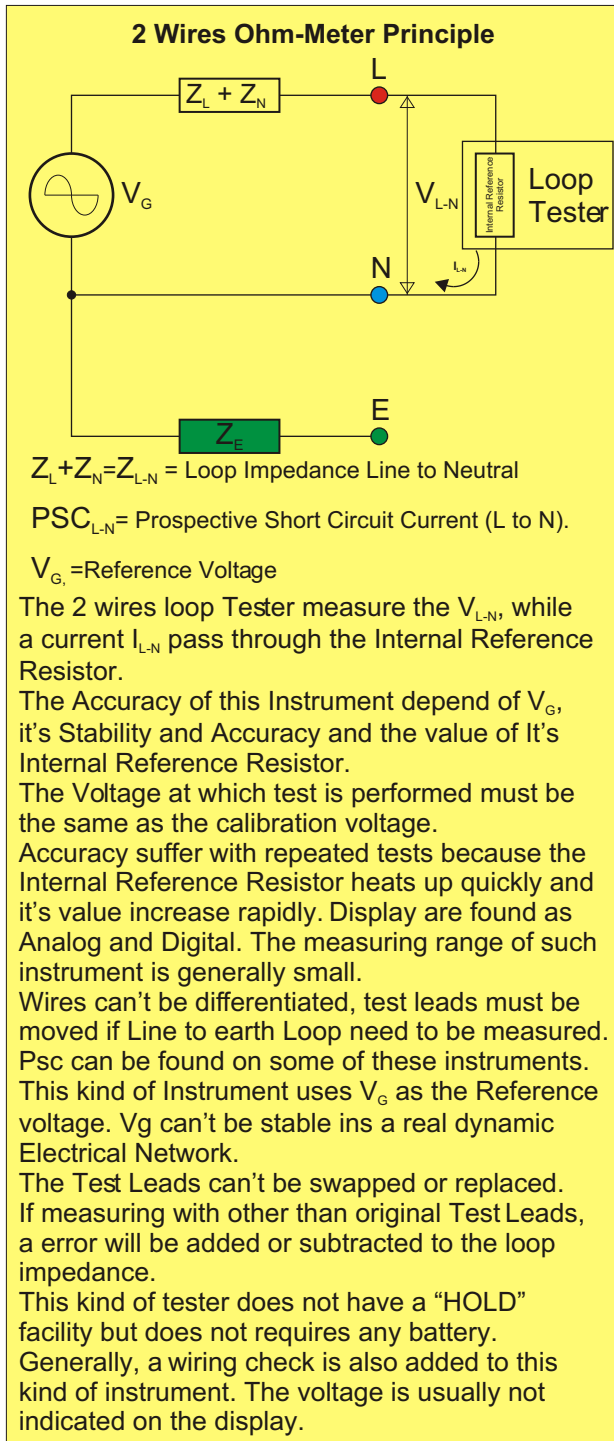## What influences the Measurements off Loop/Psc/Network Analysis?

1- The Loop Impedance itself, of course (in a dynamic network, it's changing all the time from the measurement point).
2- Temperature (Copper resistance increases with Temperature (time of the day)).
3- Load switching ON and OFF (time of the day versus loads).
4- Voltage Variation during testing (more loading on the transformer, more resistives losses.
5- Current of test (Current increase losses, and also reduce some contact losses, test current higher than reated current of some equipment is definitively out of the question).
6- Closure Resistance of contactors and/or circuit breakers.
7- Type of conductors used (bus bars versus wires, type of material etc . . .).
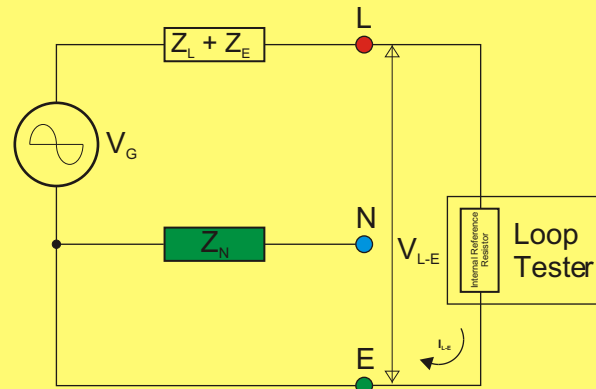8- Transformer quality.
9- Impedance of Bonding Points.

Z_L=Line (Hot) wire impedance including the transformer impedance.
Z_N=Neutral wire impedance.
Z_E=Earth (Ground) path impedance including all the connections.
PSC_{L-E}, PSC_{L-N}= Prospective Short Circuit Current (L to N) & (L to E).
V_G=Electrical Network Supply Voltage Transformer (without Load).
V_{L-N}, V_{L-E}=Voltage between L-N & L-E (without Load).

For our Analysis, we will use Z_L as being the sum of all Impedances found in the Line circuit, Z_N as being the sum of all Impedances found in the Neutral circuit, Z_E as being the sum of all Impedances found in the Earth circuit. *All as Seen from the Instrument*.

Simplified Network used for our Analysis

Page 3

How does a two wires Loop Tester works?

They are mainly using principle of an ohm-meter. You need a stable power supply (In the case of the conventional two wire loop tester, the power utility supply voltage is taken as the "Reference Voltage" of the "Ohm-Meter".

2 Wires Ohm-Meter Principle

$Z_L+Z_N=Z_{L-N}$ = Loop Impedance Line to Neutral

PSC_{L-N}= Prospective Short Circuit Current (L to N).

$V_{G,}$ =Reference Voltage

The 2 wires loop Tester measure the V_{L-N}, while a current I_{L-N} pass through the Internal Reference Resistor.
The Accuracy of this Instrument depend of V_G, it's Stability and Accuracy and the value of It's Internal Reference Resistor.
The Voltage at which test is performed must be the same as the calibration voltage.
Accuracy suffer with repeated tests because the Internal Reference Resistor heats up quickly and it's value increase rapidly. Display are found as Analog and Digital. The measuring range of such instrument is generally small.
Wires can't be differentiated, test leads must be moved if Line to earth Loop need to be measured.
Psc can be found on some of these instruments.
This kind of Instrument uses V_G as the Reference voltage. Vg can't be stable ins a real dynamic Electrical Network.
The Test Leads can't be swapped or replaced.
If measuring with other than original Test Leads, a error will be added or subtracted to the loop impedance.
This kind of tester does not have a "HOLD" facility but does not requires any battery.
Generally, a wiring check is also added to this kind of instrument. The voltage is usually not indicated on the display.

Advanced 2 Wires Ohm-Meter Principle

$Z_L+Z_E=Z_{L-E}$ = Loop Impedance Line to Earth.

PSC_{L-E}= Prospective Short Circuit Current (L to E).

$V_{G,}$ =Reference Voltage (electricity supply)

The Advanced 2 wires loop Tester measure the V_{L-E} (or V_{L-N} if connected to L-N) voltage, while a current I_{L-E} pass through the Internal Reference Resistor. This measured voltage is then compared to the Reference Voltage. The Digital Display will show a certain ratio which is proportional to the measured impedance Z_L+Z_E.
The Accuracy of this Instrument depend of V_G, it's Stability and Accuracy and the value of It's Internal Reference Resistor.
Accuracy suffer with repeated tests because the Internal Reference Resistor heats up quickly and it's value increase rapidly. Display is Digital.
Wires can't be differentiated, test leads must be moved if Line to Neutral Loop need to be measured.
Psc can be found on some of these instruments.
This Instrument uses V_G as the Reference voltage. Vg can't be stable in a real dynamic Electrical Network.
The Test Leads can't be swapped or replaced.
If measuring with other than original Test Leads, a error will be added or subtracted to the loop impedance.
This kind of tester have a "HOLD" facility but does not requires any battery (value is on "HOLD" until the capacitor run out.
Generally, a wiring check is also added to this kind of instrument. In some cases, the voltage is indicated on the display.

Microprocessor Controlled 2 Wires Ohm-Meter Principle
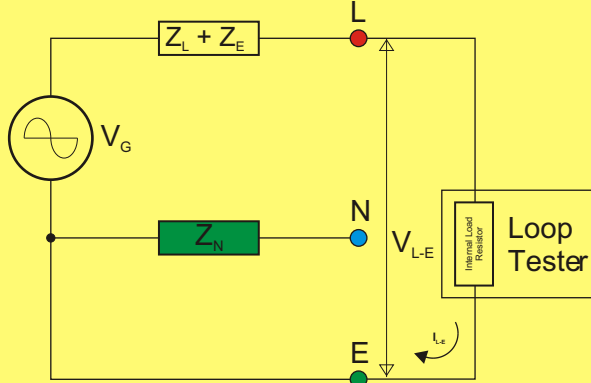
$Z_L + Z_E = Z_{L-E}$ = Loop Impedance Line to Earth.

PSC_{L-E} = Prospective Short Circuit Current (L to E).

V_G, =Reference Voltage (electricity supply)

The Microprocessor Controlled 2 wires loop Tester measure V_G (system Voltage) while no current is flowing into the Internal Load Resistor of the Tester.

It memorize that result for later use. That voltage can also be displayed on some models.

This instrument inject a Current I_{L-E} and measure it. During this injection of current, not only I_{L-E} is measured, but the voltage V_{L-E} (Function of I_{L-E}) too. The Microprocessor can then calculate the voltage present on the impedance $Z_L + Z_E$ while the current is flowing. This voltage is $V_{(ZL+ZE)} = V_G - V_{L-E.}$.

Now, the $Z_L + Z_E$ can be calculated by dividing the voltage on the impedance by the current which circulated during the test.

$Z_L + Z_E = V_{(ZL+ZE)} / I_{L-E}$

Same can be repeated for the $Z_L + Z_N$ impedance. This tester does not need an Internal Reference Resistor, only a resistor to pass enough current. The Accuracy of this Instrument depend of V_G, it's **Stability** only during the test, **not It's Accuracy** and **not** the value of It's Internal Resistor.

Accuracy **does not** suffer with repeated tests. Display is Digital. Psc can be easily calculated too. Wires can't be differentiated, test leads must be moved if Line to Neutral Loop need to be measured.

This Instrument uses V_G as the Reference voltage. Vg can't be stable in a real dynamic Electrical Network.

The Test Leads can't be swapped or replaced. If measuring with other than original Test Leads, a error will be added or subtracted to the loop impedance. **This problem can be eliminated by the use of four wires**. (Two for voltages measurement, two for current injection).

This kind of tester have a "HOLD" facility but requires battery. Generally, a wiring check is also added to this kind of instrument. In some cases, the voltage is indicated on the display.

Three Wires Loop/Psc/Earth/Electrical Network Analyzer

Electrical Supply and Distribution   Point of Test, or Socket Outlet
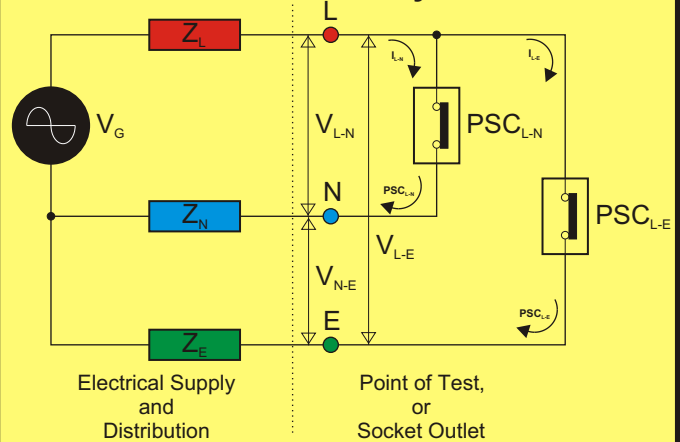
The Instrument measure V_G while no current is flowing. Then, inject I_{L-N}, while I_{L-N} is flowing, it measure V_{L-N} (function of I_{L-N})= $V_{L-N(Fct\ ILN)}$.

At the same time, it measure $V_{N-E(Fct\ IL-N)}$.

This now give us enough information to compute some equation end get:

$Z_N + Z_L$
Z_N
Z_L

Now by applying the current I_{L-E} and using a similar method, we can get:

Z_E

The Prospective Short Circuit Currents are calculated using the previous measurement and results of equations.

Voltage are also measured and displayed:

V_{L-E}
V_{L-N}

The problem of the test leads resistance remain but can be solved using 5 or 6 wires method.

The Voltage stability of the system while testing occurs still affect the accuracy of this instrument (like any other). This instrument has the advantage of giving you all the parameters of the electrical network as seen from the instrument point of vue.

No Instrument can actually solve a Loop/Psc result in an dynamic electrical network while in use.

Page 5

Lets have a look at an example of Electrical Network. For the purpose of this explanation, we will use a DC power supply and Resistors and simplification using Thevenin and Kirkoff Laws.
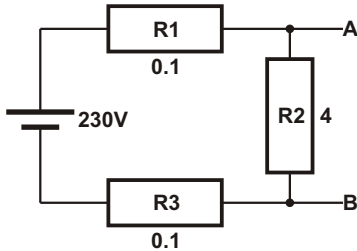
For example, R1 and R2 could be Wires transporting electricity from the power supply to the user.

R1 0.1 — A
230V
R3 0.1 — B

$R_{equiv. (R1+R3)}$ 0.2 — A
230V
B
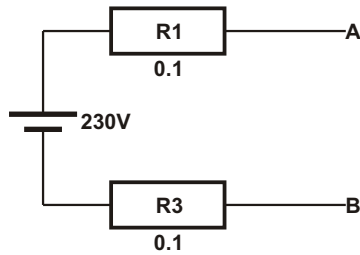
The Prospective Short Circuit between A and B
is the current which will flow from A to B if a
short circuit is made between Points A and B.
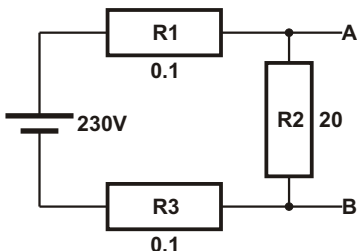In this case, the Psc (A-B) = 230/(0.1+0.1) = 1150A
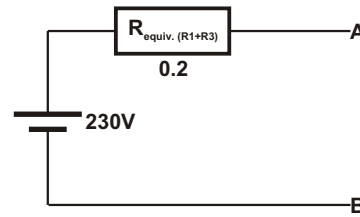
The Loop resistance between A and B
is the resistance which will be seen
when measuring between Points A and B.
In this case the Loop Resistance is 0.1+0.1=0.2

R1 0.1 — A
230V
R2 4
R3 0.1 — B

⇒

$R_{equiv. (R1+R3)}$ 0.2 — A
230V
R2 4
B

⇒

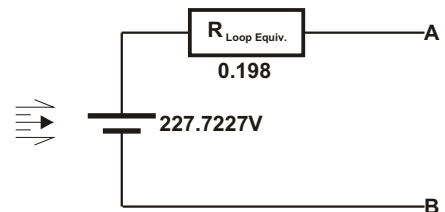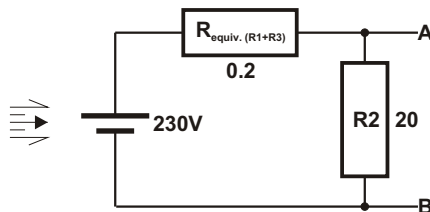$R_{Loop Equiv.}$ 0.19 — A
219.0476V
B

If for example, your neighbor use a heater
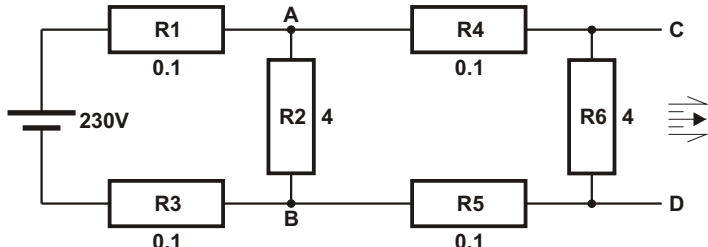which is 4 ohms, what will happen to the
Loop Impedance and the Psc?
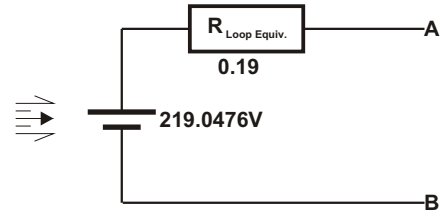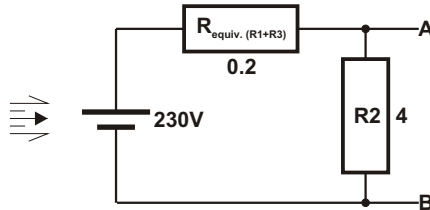
By having your neighbor using his heater
(loading the system), it has the same effect of
actually lowering the voltage at the supply
utility, and also has the same effect as lowering
the loop impedance. In this case, it also has same
effect as increasing the Psc = 219.0476/0.19=1155.13A

R1 0.1 — A
230V
R2 20
R3 0.1 — B

⇒

$R_{equiv. (R1+R3)}$ 0.2 — A
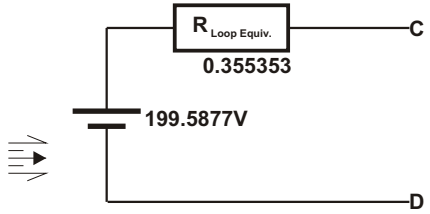230V
R2 20
B

⇒

$R_{Loop Equiv.}$ 0.198 — A
227.7227V
B

If for example, your neighbor use a smaller
heater which is 20 ohms, what will happen
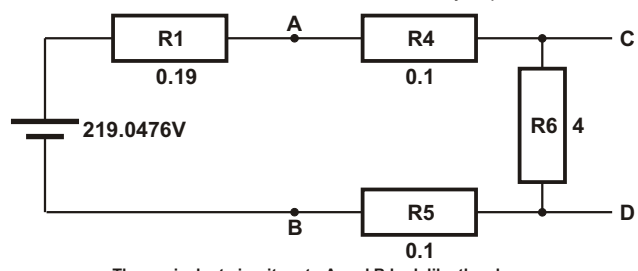to the Loop Impedance and the Psc?

By having your neighbor using his heater
(loading the system), it has the same effect of
actually lowering the voltage at the supply
utility, and also has the same effect as lowering
the loop impedance (not as much). In this case,
it also has same effect as increasing slightly the
Psc = 227.7227/0.198=1150.114A

R1 0.1   **A**   **R4** 0.1   **C**

230V   **R2** 4   **R6** 4

R3 0.1   **B**   **R5** 0.1   **D**

R1 0.19   **A**   **R4** 0.1   **C**

219.0476V   **R6** 4

B   **R5** 0.1   **D**

The equivalent circuit up to A and B look like the above

If for example, two neighbors, each, use a heater which is 4 ohms, what will happen to the Loop Impedance and the Psc seen from C and D?

R Loop Equiv. 0.355353   **C**

199.5877V   **D**

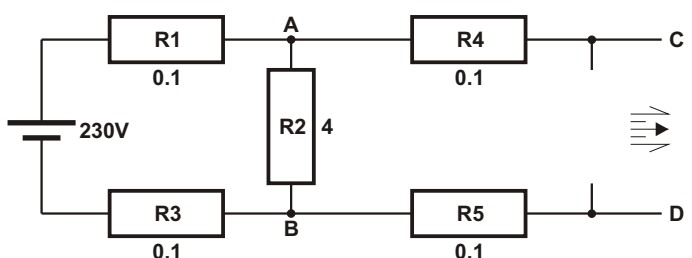Psc depend of the loads being used (time of the day)

By having two neighbors using their heaters (loading the system), it has the same effect of actually lowering the voltage at the supply utility, and also has the same effect as increasing the loop impedance (mainly due to the distance between houses). In this case, it also has same effect as decreasing the
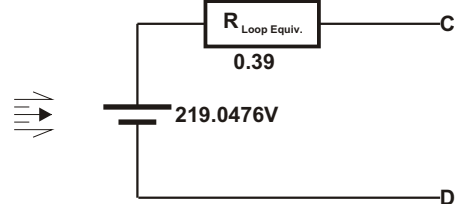Psc = 199.5877/0.355353=561.66A

R1 0.1   **A**   **R4** 0.1   **C**

230V   **R2** 4

R3 0.1   **B**   **R5** 0.1   **D**

R1 0.19   **A**   **R4** 0.1   **C**

219.0476V

B   **R5** 0.1   **D**

The equivalent circuit up to A and B look like the above

If Neighbor R6 is not at home and is gone with all the load OFF. What will happen to the Loop Impedance and the Psc seen from C and D?

R Loop Equiv. 0.39   **C**

219.0476V   **D**

Psc Depend where you are measuring in the network.

The Network is the same as before, the only difference is the load being switched on and off, but...the loop impedance change and the psc change too.
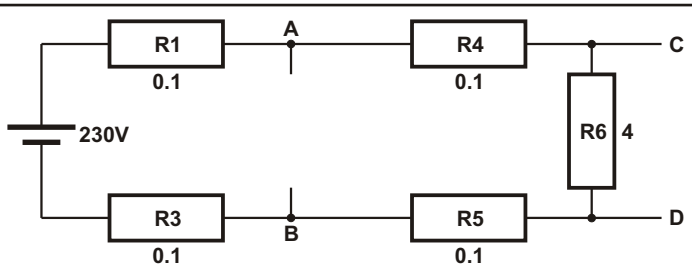
By having on neighbor using it's heaters (loading the system) but not at the same place, has the sam effect of actually lowering the voltage at the supply utility, and also has the same effect as increasing the loop impedance (mainly due to the distance between houses). In this case, it also has same effect as decreasing the
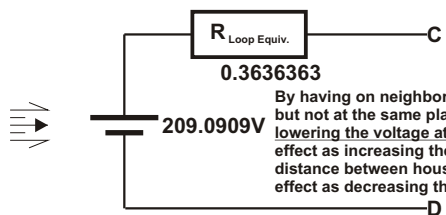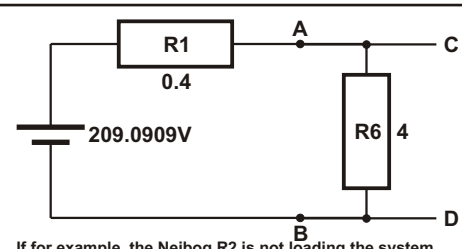Psc = 219.0476/0.39=561.65A

R1 0.1   **A**   **R4** 0.1   **C**

230V   **R6** 4

R3 0.1   **B**   **R5** 0.1   **D**

R1 0.4   **A**   **C**

209.0909V   **R6** 4

B   **D**

If for example, the Neibog R2 is not loading the system, what will happen to the Loop Impedance and the Psc seen from C and D?

R Loop Equiv. 0.3636363   **C**

209.0909V   **D**

If for example, the Neibog R2 is not loading the system, what will happen to the Loop Impedance and the Psc seen from C and D?

Psc depend of the temperature.

By having on neighbor using it's heaters (loading the system) but not at the same place, has the same effect of actually lowering the voltage at the supply utility, and also has the same effect as increasing the loop impedance (mainly due to the distance between houses). In this case, it also has same effect as decreasing the Psc = 209.0909/0.3636363=575A

Page 7

EARTH

HOUSE 1   **HOUSE 2**   **HOUSE 3**

EARTH Page 8
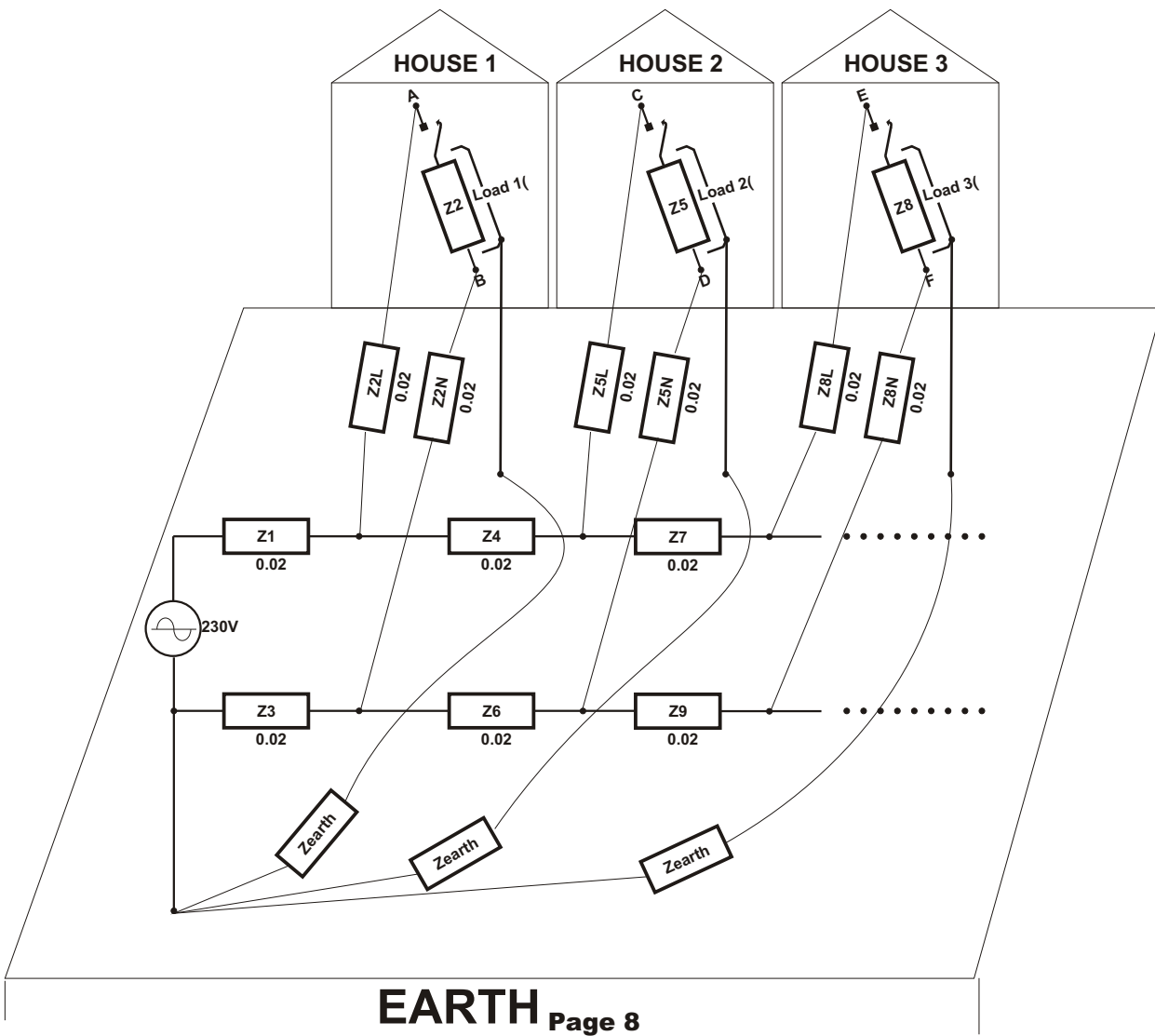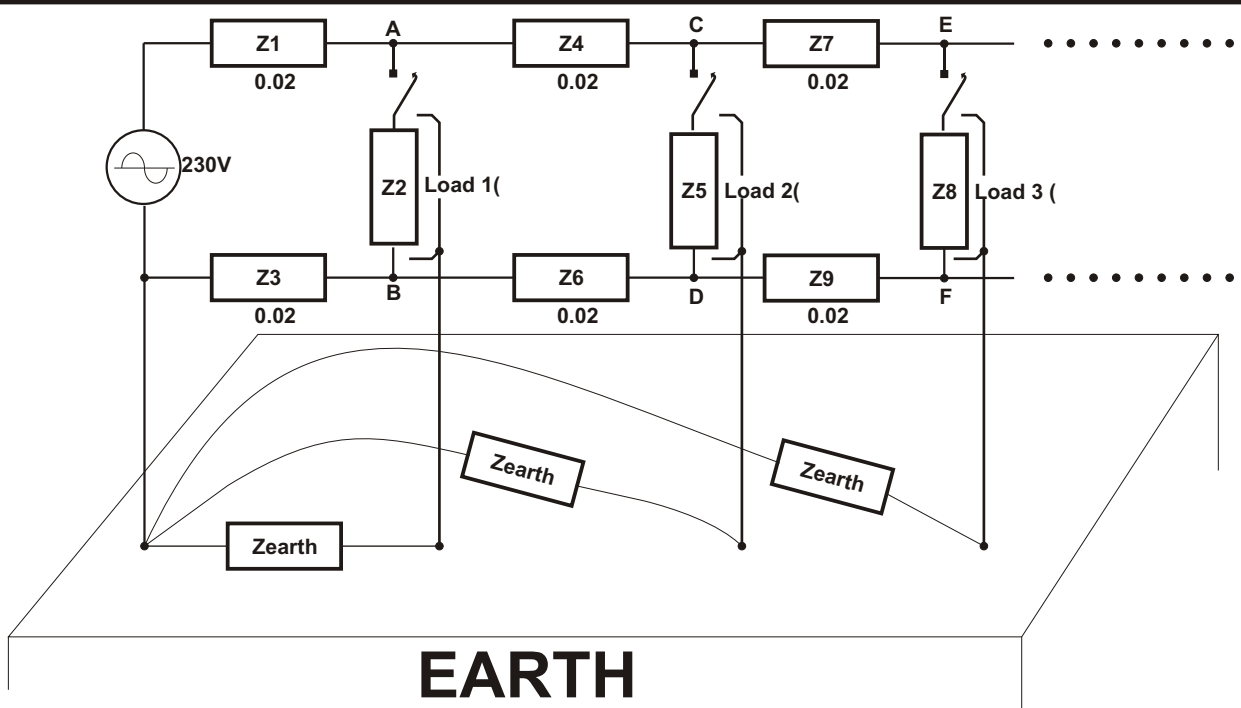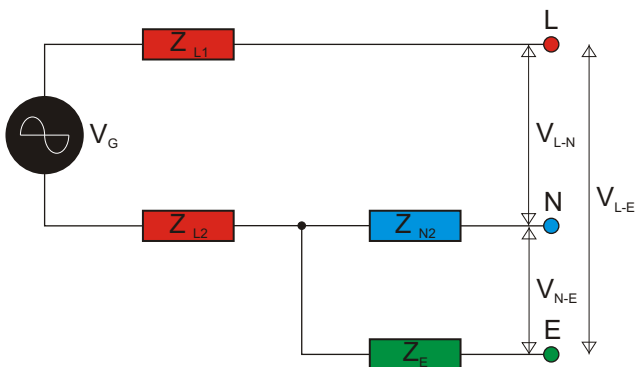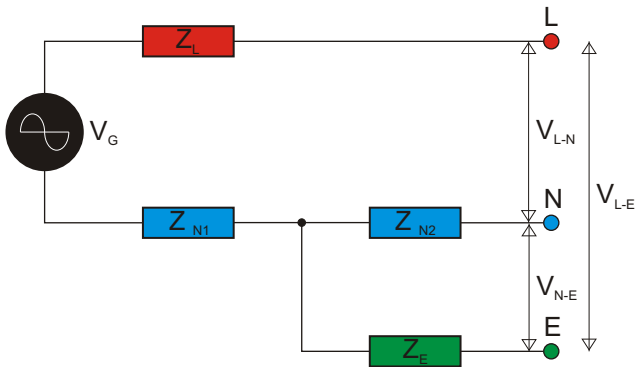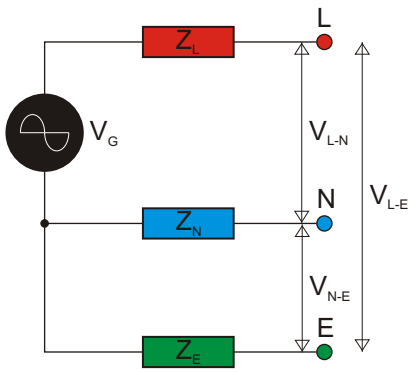
Ohmique Elevation by temperature

L

Z_L

V_G

V_{L-N}

N

V_{L-E}

Z_N

V_{N-E}

E

Z_E

Not all the wires are born equals

L

Z_L

V_G

V_{L-N}

N

V_{L-E}

Z_{N1} Z_{N2}

V_{N-E}

E

Z_E

L

Z_{L1}

V_G

V_{L-N}

N

V_{L-E}

Z_{L2} Z_{N2}

V_{N-E}

E

Z_E

Contact Resistance and Temperature

Constant Neutral.
(If link at the house)
Constant Earth.
Never
Not Constant Line.

Can you trust a Measurement?

What is the 1826NA actually do?

Changes on Impedance after wiring modifications.

What is the 1826NA actually don't do?

In a normal network, the internal Impedance of the source limit the total available current from the power supply.

Is Loop/Psc Measurement useful for anyone?

The closer to the source, the higher the Psc., Or the more the psc you should get.

Web: HTTP://WWW.SEW.COM.TW E-Mail: Jacques@SEW.COM.TW

Page 10

But !!!!! Why do you need to take the Loop/Psc Measurement?

Why is the Earth Impedance stable in a dynamic network?
1- Good Earth Impedance should be as low as possible.
2- Earth Impedance is not switched on and off.
3- Unlike Neutral and Line impedances, Earth Impedance is near Constant in a network.

Three wires methods advantages?
1- Similar problems with the Test Leads Resistance
2- Temperature Problem of Internal Resistance does not influence the measurement.
3- Multivoltage.

1- Temperature of Internal Resistors.
2- Calibration of the Instrument.
3- Test Leads Resistance is an error (can be calibrated with the supplied test leads, but any use of other test leads requires a new Calibration).
4- Operating Voltage need to be fixed. (Fixed system voltage). The Instrument can only be calibrated at one voltage.
5- Results are too stable to be true (using an averaging integrating method which is related to the Sine versus of time.
6- Impedances and/or Wiring can't be differentiated, we only get the sum of Line and Neutral or Line and Earth Impedances.

Why I don't believe repeated stable readings

The 2 wires loop Tester measure the V_G, store that value into a capacitor, then injects a current through it's Internal Reference Resistor, measure that voltage V_{L-N} while the current is passing through the loop, stores it into an other capacitor then uses these two voltages to work out a ratio compared to the Internal Reference Resistor. The working Voltage range is very small, the Internal Reference Resistor change with repeated tests

What happen when the Load Changes?

How do you calibrate a two wire Loop/Psc instrument?

1- Impedance of Line and Reflected impedance Transformer upstream of the Transformer is unknown.

2- Voltage may not be stable.

3- Resistance of test Leads must be known.

4- Current is very high in general, much higher the than rated equipment in the circuit (sockets, switches, etc...).

What happen when the Test Current Changes?
1- If the Test Current is too Low.
2- If the Test Current is too High.

What happen when the Voltage Changes?
1- If the voltage during load if higher than before Load.
2- If the voltage during load is lower than what is should be due to losses.

Why Averaging of results is useless.

What happen when the Temperature Changes?
1- Copper changes
2- Transformer changes
3-

Current sensing problems in general?

You'll be the Judge

Prospeective Short Circuit change with Temperature of Copper.

Having more users on the system is the same as having a total lower impedance, but also having less Psc available per user too...or isn't?.

Can a Loop/Psc Tester give you a stable Reading?

What is the 1825LP?

Page 14

Results calculated Versus Results Meeasured.

Results shows a lower Psc at Night.

Changes after changing circuit Breakers.

Changes after screwing contact points and connection points.

What is the 1824LP?

Changes in Transformers Internal Impedance.

Changes test Lead Resistance

What can our 1826NA tell you?

Two Wires testers Can't be Trusted.

Solving the test Leads Resistance.

Increasing the total load is the same as lowering the total impedance.

Influence of Test Leads Resistance.

What and when is the worst Case?

Lowering the impedance per user is the same as lowering the Psc per user too. .

Many Accidents and fires occurs when Psc is the highest.t.

Loop Impedance change with Temperature of Copper.

Changes in Projected input Impedance on Transformer's Primary.

The Information you should be getting from the Elctricity supply Authoirty

Changes in Circuit Breaker re-closing resistance

Stable Readings can't be trusted.

Summer / Winter changes in Loop Impedance.

LOOP IMPEDANCE - PSC - EARTH TESTER

The 1824LP is the first of a new generation of electrical instruments for testing electrical installations. It has a **built-in Earth tester** which does not require the use of poles or long wires.

This instrument is useful for fault-finding or commissioning of Domestic electrical installations. This new instrument uses a three wires unique principle of operation.

It displays the main **system voltage** of the power utility, without loading the wiring.

The 1824LP displays the **Loop Impedance** between Line and Earth $(Z_L + Z_E) = Z_{L-E}$ and **Prospective Short Circuit** between Line and Neutral.

••••••••The 1824LP is so *simple to use* that you can **focus on solving rapidly the electrical problem** instead of having to study the instruction manual.••••••

Our 1824LP uses "*multiple paths high current injection* " for it's tests. The measured values are well above network noise and that current injection is closer to real life current values, thus, test occurs close to real life use, where results are the most important.

Once the integrity of the wiring has been verified, the "Smart" button can be depressed.

Firstly, the instrument will measure the *voltage of the electricity supplier* (utility company) at the source(V_G).

A *high current* is then injected between Line and Neutral from the point where the test is performed. All the results (voltages and currents) from this measurement are stored in a non volatile memory inside the microprocessor. Then, a high current is injected between Line and Earth from the same test point (fully automated, the user's has nothing to do), currents and voltages are again measured and stored. From now, the microprocessor has enough information to compute all the necessary results to display.

The "Smart" button can be depressed to scroll through the relevant information.

With the 1824LP, the electrical engineer can quickly ascertain if basic components of the network are healthy or if a problem is present between Line to Neutral, Line to Earth or in the Earth path.

The Earth path is measured and calculated without the need for poles or long wires to be used.

The Earth path shown on the instrument is *exactly* what the earth current will be going through.

Prospective Short Circuit Current between Line-Neutral and Loop Impedance between Line-Earth are displayed as well as Earth Spike Resistance.

Z_E= Earth Resistance, Spike resistance.

$Z_L + Z_E = Z_{L-E}$ = Loop impedance.

PSC_{L-N}= Prospective Short Circuit Current (L to N).

$V_{L-N,}$ =Main Voltage (without Load).
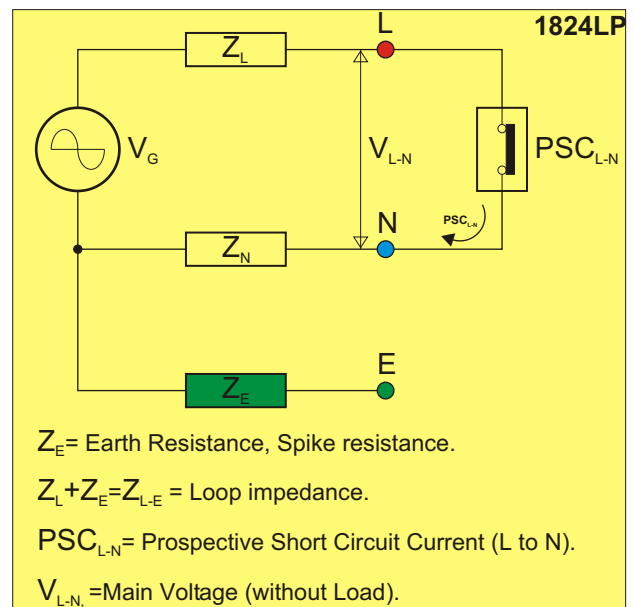
TECHNICAL SPECIFICATION

Loop Impedance Range L-E	0.08-2000V (Software Ctrl)
Test Currents in Each Loop	11.76A @ 230V/50Hz
Voltage Measurement L-N,L-E	50 to 280V AC (Sine)
Earth Wire/Path Return Resistance	0.03-2000V (Software Ctrl)
Neutral Wire Resistance	Only available with 1826NA
Line Wire Resistance & Transformer Windings	Only available with 1826NA
PSC Current (L-N) Max	3KA@230Vac supply
PSC Current (L-E) Max	Only available with 1826NA
Operating Voltage	230V ±50% @50Hz Sine
Dimensions (LxWxD)	(170x165x92)mm
Weight	970g
Power Source	8 x AA Batteries
Typical Accuracy	
Loop Impedance	6% of FS ±2 dgt
PSC Current	15% of FS ±5 dgt
Voltage	3% of FS ±1 dgt
Operating-Temperature -Humidity	-10 °C to + 40 °C 80% max relative humidity

- Measures Earth Resistance without the need for poles in the ground or external measuring wires.
- Earth Measurement uses the real earth current path and the current generated by the electric network, without the need for any disconnection.
- The displayed Earth Resistance is exactly the earth resistance that the earth current will need to go through if an earth fault occurs. (You do not need to add all the bonding points and connection paths).
- Displays voltage supply at the transformer (Line to Neutral), without loading the transformer.
- Single One Smart Push button operation; ON, Scroll through results and menus.
- Checks wiring integrity (LEDs).
- Auto-off / Auto-ranging (software range).
- Microprocessor controlled.
- Combined Prospective Short circuit Current, Loop and Earth Tester.
- Loop test for L-E and PSC between L-N.
- Voltage test L-N .
- Test leads, shoulder belt, user's manual.
- 60HZ available upon request.
- Display can be customized for large orders.
- 60Hz available upon request.
- IEC 1010 CAT. III.

The 1824LP is the first portable electrical Loop Impedance / PSC tester which has a built-in Earth tester, and which does not require the use of poles or long wires.

This instrument is useful for fault-finding or commissioning of domestic electrical installations.
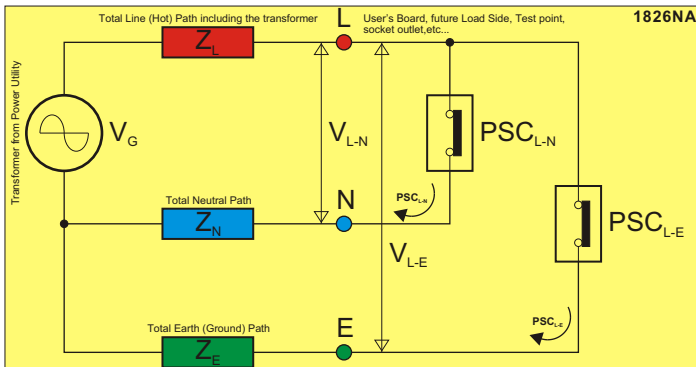
Appreciating the Earth(ground) path by reading its value has never been easier.

Bad contacts, old wiring or bad earth path can be identified.

Faulty electrical network can be resolved in a fraction of the time normally required using conventional equipment.

Down time due to a faulty electrical network is minimal as the fault can be identified quickly.

Find which loop need to be attended to and why. (find those old wires with high impedance before a fire starts, and replace them).

The simplified electrical network can be deduced by scrolling through the results.

For Electrical Network Analazys, See 1826NA

Z_L=Line (Hot) wire impedance including the transformer impedance.
Z_N=Neutral wire impedance.
Z_E=Earth (Ground) path impedance including all the connections.
PSC_{L-E}, PSC_{L-N}= Prospective Short Circuit Current (L to N) & (L to E).
V_G=Electrical Network Supply Voltage Transformer (without Load).
V_{L-N}, V_{L-E}=Voltage between L-N & L-E (without Load).

Please note: Instrument accuracy depend of VG stability while testing.

PERFORMANCE SELECTOR	1824LP
Wiring OK Indication	•
Reversed Wiring Indication	•
Smart Control One Push Button	•
Microprocessor Controlled	•
CMOS Low Consumption	•
Display System Voltage (Line to Neutral)	•
Display Line Path Impedance	1826NA
Display Neutral Path Impedance	1826NA
Display Earth Path Impedance	•
Display Prospective Short Circuit L-N	•
Display Prospective Short Circuit L-E	1826NA
Re-scroll Through Previous Results	•
Bat. OK / Low Battery Indicator	•
Scroll Through Previous Results	•
Auto-Off Function	•
Test Leads Compartment In The Case	•
Retractable Handle	•
Color Coded Test Leads	•
Display Voltage Line to Earth	1826NA
Two wire operation Line to Earth possible	1826NA
Strap and Battery Supplied	•
Very Low Consumption	•

Specifications are subject to change without notice.

LOOP IMPEDANCE - PSC - LOAD TESTER

The 1825LP is a new kind of instrument. It displays the main **system voltage** (V@0A) of the power utility and calculates the **volt drop** between Line and Neutral as if 16A was flowing between Line to Neutral. The **built-in Load Tester** does not require the use of heavy high power resistor elements to measure the "On-Load" volt drop. **This instrument is useful for fault-finding or commissioning of Domestic electrical installations**. It has a three wires unique principle of operation. The 1824LP displays the **Loop Impedance** between Line and Earth $(Z_L + Z_E) = Z_{L-E}$ and **Prospective Short Circuit** between Line and Neutral.

••••••••The 1825LP is so **simple to use** that you can **focus on solving rapidly the electrical problem** instead of having to study the instruction manual.••••••

Our 1825LP uses "**multiple paths high current injection** " for its tests. The measured values are well above network noise and current injection is closer to real life current values, thus, test occurs close to real life use, where results are the most important.

Once the integrity of the wiring has been verified, the "Smart" button can be depressed.

Firstly, the instrument will measure the **voltage of the electricity supplier** (utility company) at the source(V_G). A **high current** is then injected between Line and Neutral from the point where the test is performed. All the results (voltages and currents) from this measurement are stored in a non-volatile memory inside the microprocessor. Then, a high current is injected between Line and Earth from the same test point (fully automated, the user's has nothing to do), currents and voltages are again measured and stored. From now, the microprocessor has enough information to compute all the necessary results to display.

The "Smart" button can be depressed to scroll through the relevant information.

With the 1825LP, the electrical engineer can quickly ascertain if basic components of the network are healthy or if a problem is present between Line to Neutral or Line to Earth.

$V_{L-N,}$ =Main Voltage (with Load=V@16A).

$Z_L + Z_E = Z_{L-E}$ = Loop impedance.

PSC_{L-N}= Prospective Short Circuit Current (L to N).

$V_{L-N,}$ =Main Voltage (without Load=V@0A).

The Voltage after volt drop is displayed using the calculation facility of the microprocessor without the need for heavy, high power electrical elements.

The voltage between Line and Neutral shows on the instrument is **exactly** the voltage which will be measured between Line and Neutral if 16A flows between those two points.

Prospective Short Circuit Current between Line-Neutral and Loop Impedance between Line-Earth are displayed as well as the resulting voltage between Line and Neutral, just as if 16A was taken from Line-Neutral.
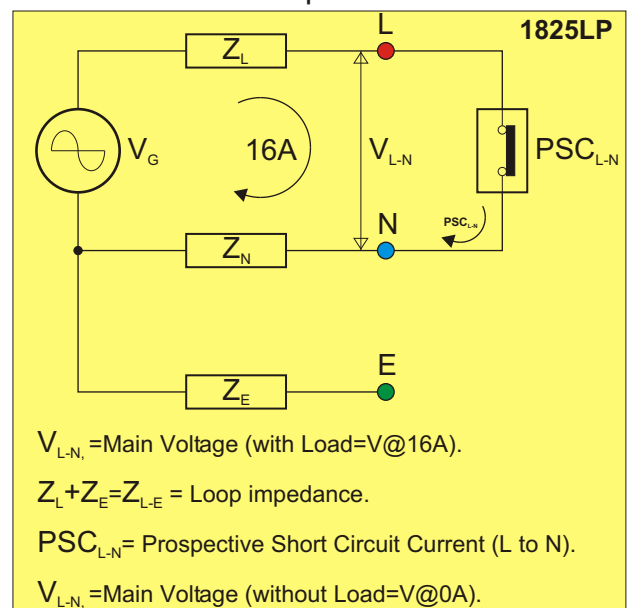
TECHNICAL SPECIFICATION	
Loop Impedance Range L-E	0.08-2000Ω (Software Ctrl)
Test Currents in Each Loop	11.76A @ 230V/50Hz
Voltage Measurement (0A - 16A)	50 to 280V AC (Sine)
Earth Wire/Path Return Resistance	Not available on this model
Neutral Wire Resistance	Only available with 1826NA
Line Wire Resistance & Transformer Windings	Only available with 1826NA
PSC Current (L-N) Max	3KA@230Vac supply
PSC Current (L-E) Max	Only available with 1826NA
Operating Voltage	230V ±50% @50Hz Sine
Dimensions (LxWxD)	(170x165x92)mm
Weight	970g
Power Source	8 x AA Batteries
Typical Accuracy	
Loop Impedance	6% of FS ±2 dgt
PSC Current	15% of FS ±5 dgt
Voltage	3% of FS ±1 dgt
Operating-Temperature -Humidity	-10 °C to + 40 °C 80% max relative humidity

- Measures the volt drop as if 16A was flowing between Line and Neutral.
- Displays voltage without current (V@0A).
- Display voltage as if 16A flows between Line and Neutral (V@16A).
- Loop test for L-E.
- PSC between L-N.
- One Smart Push button operation; ON, Scroll through results and menus.
- Checks wiring integrity (LEDs).
- Auto-off / auto-ranging (software range).
- Microprocessor controlled.
- Combined Prospective Short circuit Current, Loop and Load Tester.
- Test leads, shoulder belt, user's manual.
- 60Hz available upon request.
- Display can be customized for large orders.
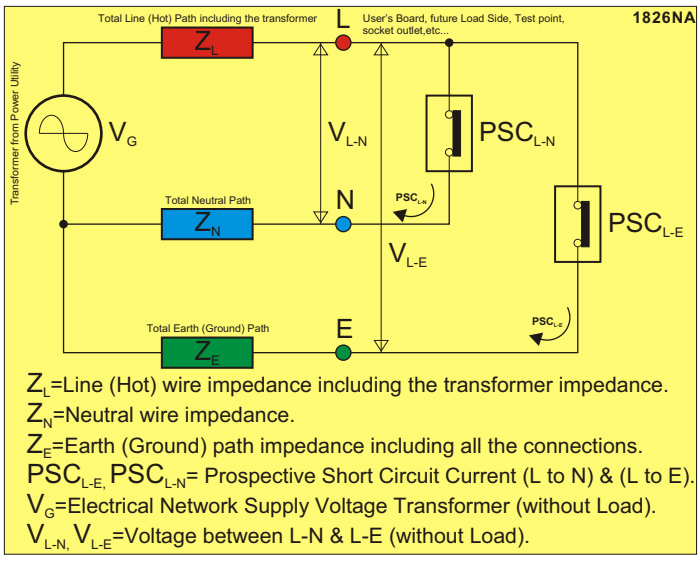- 60Hz available upon request.
- IEC 1010 CAT.III.

The 1825LP is an instrument which displays the main **system voltage** (V@0A) of the power utility and calculates the **volt drop** between Line and Neutral as if 16A was flowing between Line to Neutral. 1825LP displays the system voltage minus the voltage lost into the Line and Neutral impedances (lost due to the current circulating into these impedances).
The result of this dropped **voltage is displayed as if you had a 16A load** (V@16A). This instrument is useful for fault-finding or commissioning of domestic electrical installations.

The 1825LP displays the **Loop Impedance** between Line and Earth $(Z_L+Z_E)=Z_{L-E}$ and **Prospective Short Circuit** between Line and Neutral.

The simplified electrical network can be deducted by scrolling through the results.

For Electrical Network Analyzer, See 1826NA

Z_L=Line (Hot) wire impedance including the transformer impedance.
Z_N=Neutral wire impedance.
Z_E=Earth (Ground) path impedance including all the connections.
PSC_{L-E}, PSC_{L-N}= Prospective Short Circuit Current (L to N) & (L to E).
V_G=Electrical Network Supply Voltage Transformer (without Load).
V_{L-N}, V_{L-E}=Voltage between L-N & L-E (without Load).

Please note: Instrument accuracy depend of VG stability while testing.

PERFORMANCE SELECTOR	1825LP
Wiring OK Indication	•
Reverse Wiring Indication	•
Smart Control One Push Button	•
Microprocessor Controlled	•
CMOS Low Consumption	•
Display System Voltage (Line to Neutral)	•
Display Line Path Impedance	1826NA
Display Neutral Path Impedance	1826NA
Display Earth Path Impedance	1826NA
Display Prospective Short Circuit L-N	•
Display Prospective Short Circuit L-E	1826NA
Re-scroll through previous results	•
Bat. OK / Low Battery Indicator	•
Scroll Through Previous Results	•
Auto-Off Function	•
Test Leads Compartment In The Case	•
Retractable Handle	•
Color Coded Test Leads	•
Display Voltage Line to Earth	1826NA
Two Wire Operation Line to Earth Possible	1826NA
Strap and Battery Supplied	•
Very Low Consumption	•

Specifications are subject to change without notice.

ELECTRICAL NETWORK ANALYZER

Conventionally, when you had to analyze an electrical network or find a fault quickly, the electrical engineer had to buy many bulky expensive test instruments. This latest release of the SEW Electrical Network Analyzer, model 1826NA solves that problem.

The 1826NA has a built-in LED **wiring check** which checks the correctness of the wiring under test.

This microprocessor controlled, superb piece of equipment that has **one "Smart" push button** -does it all- type.

Press it to turn the instrument "ON", press it to TEST, press it to SCROLL through the results, press it to scroll through PREVIOUS results or press it to START an other test.

••••••••The 1826NA is so **simple to use** that you can **focus on solving rapidly the electrical problem** instead of having to study the instruction manual.••••••

Our Electrical Network Analyzer uses "**multiple paths high current injection** " for its test so that the measured values are well above network noise and high current injection is closer to reality. Once the integrity of the wiring has been verified, the "Smart" button can be depressed.

The instrument will first measure the **voltage of the electricity supplier** (utility company) at the source. (V_G).
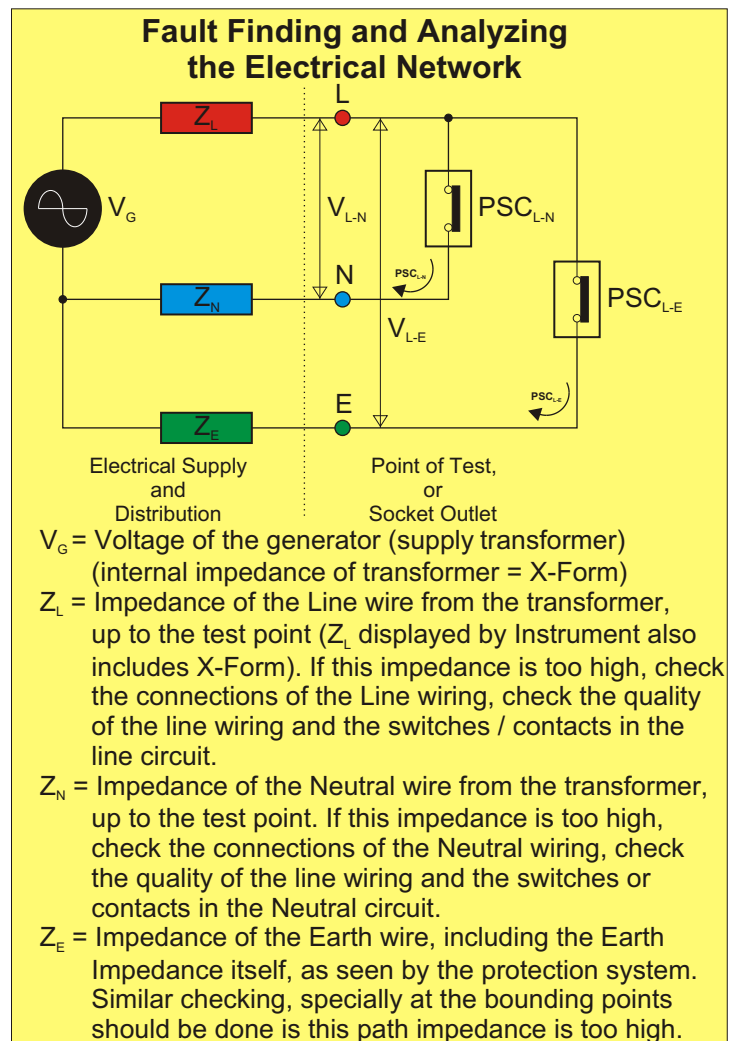
A **high current** is then injected between Line and Neutral from the point where the test is performed. All the results (voltages and currents) from this measurement are stored in a non volatile memory inside the microprocessor. Then, a high current is injected between Line and Earth from the same test point (fully automated, the user's has nothing to do), currents and voltages are again measured and stored. From now, the microprocessor has enough information to compute all the necessary results to display.

The "Smart" button can be depressed to scroll through the relevant information.

With the 1826NA, the electrical engineer can quickly ascertain if the network is healthy or if a problem is present in the Line, Neutral or Earth path of the network.

The Earth path is measured and calculated without the need for poles or long wires.

The Earth path shown on the instrument is **exactly** what the earth current will be going through. **Prospective Short Circuit Current and Loop Impedance between Line-Neutral and Line-Earth and all their components are displayed.**

Fault Finding and Analyzing the Electrical Network

Electrical Supply and Distribution

Point of Test, or Socket Outlet

V_G = Voltage of the generator (supply transformer) (internal impedance of transformer = X-Form)

Z_L = Impedance of the Line wire from the transformer, up to the test point (Z_L displayed by Instrument also includes X-Form). If this impedance is too high, check the connections of the Line wiring, check the quality of the line wiring and the switches / contacts in the line circuit.

Z_N = Impedance of the Neutral wire from the transformer, up to the test point. If this impedance is too high, check the connections of the Neutral wiring, check the quality of the line wiring and the switches or contacts in the Neutral circuit.

Z_E = Impedance of the Earth wire, including the Earth Impedance itself, as seen by the protection system. Similar checking, specially at the bounding points should be done is this path impedance is too high.

TECHNICAL SPECIFICATION

Loop Impedance Range L-E,L-N	0.03-2000 (Software Ctrl)
Test Currents in Each Loop	11.76A @ 230V/50Hz
Voltage Measurement L-N,L-E	50 to 280V AC (Sine)
Earth Wire/Path Return Resistance	0.01-2000 (Software Ctrl)
Neutral Wire Resistance	0.01-2000 (Software Ctrl)
Line Wire Resistance & Transformer Windings	0.01-2000 (Software Ctrl)
PSC Current (L-N) Max	6KA@230Vac supply
PSC Current (L-E) Max	6KA@230Vac supply
Operating Voltage	230V ±50% @50Hz Sine
Dimensions (LxWxD)	(170x165x92)mm
Weight	970g
Power Source	8 x AA Batteries
Typical Accuracy	
Loop Impedance	4% of FS ±2 dgt
PSC Current	10% of FS ±5 dgt
Voltage	2% of FS ±1 dgt
Operating-Temperature -Humidity	-10 °C to + 40 °C 80% max relative humidity

The 1826NA is the first portable electrical network analyzer. It has a built-in Earth tester which does not requires the use of poles or long wires. <u>This instrument is useful for fault-finding or commissioning of electrical installations</u>. Differentiating between the Line (hot), Neutral and Earth(ground) path by reading their values has never been easier. Bad contacts, old wiring or bad earth path are quickly identified. Faulty electrical network can be resolved in a fraction of the time normally required using conventional equipment. Down time due to a faulty electrical network is minimal as the fault can be identified and diagnosed quickly. Find which wire need to be attended to and why (find those old wires with high impedance before a fire starts and replace them). <u>The complete electrical network can be analyzed by scrolling through the results.</u>

Z_L=Line (Hot) wire impedance including the transformer impedance.
Z_N=Neutral wire impedance.
Z_E=Earth (Ground) path impedance including all the connections.
PSC_{L-E}, PSC_{L-N}= Prospective Short Circuit Current (L to N) & (L to E).
V_G=Electrical Network Supply Voltage Transformer (without Load).
V_{L-N}, V_{L-E}=Voltage between L-N & L-E (without Load).
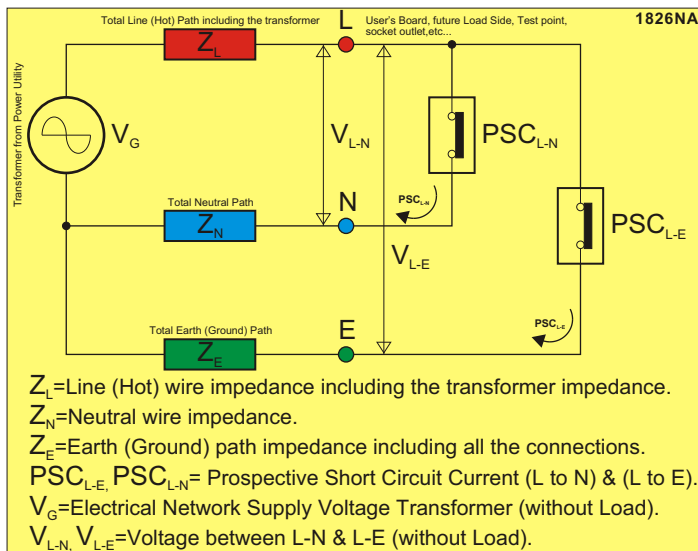
Please note: Instrument accuracy depend of VG stability while testing.

- •Measures Earth Resistance without the need for poles in the ground or external measuring wires.
- •Earth Measurement uses the real earth current path and the current generated by the electric network, without the need for any disconnection.
- •The Earth Resistance displayed is exactly the earth resistance that the earth current will need to go through if an earth fault occurs. (You do not need to add all the bonding points and connection paths resistances)
- •Displays voltage supply at the transformer (Line to Neutral), without loading the transformer.
- •Displays voltage between Line(Phase) and Earth(Ground), without drawing any current.
- •Measures the Impedance of the Line itself, so you can analyze and differentiate between the multiples paths of the wiring.
- •Measures the Neutral Impedance.
- •One Smart Push button operation; ON, Test, Scroll through results and menus.
- •Checks wiring integrity (LEDs).
- • Auto-off / auto-ranging (software ranging).
- •Microprocessor controlled.
- •Combined Prospective Short circuit current, Loop, individual wire and Earth Tester.
- •Loop test for L-E, L-N and PSC.
- •Voltage test L-N and L-E.
- •Enables analysis of constituent components in L-E and L-N loops giving resistance of earth, neutral wire, live wire and transformer winding.
- •Test leads, shoulder belt, user's manual, batteries included.
- •60HZ available upon request.
- •Displays can be customized for large orders.
- •60Hz available upon request.
- •IEC 1010 CAT.III.

PERFORMANCE SELECTOR	1826NA
Wiring OK Indication	•
Reverse Wiring Indication	•
Smart Control One Push Button	•
Microprocessor Controlled	•
CMOS Low Consumption	•
Display System Voltage (Line to Neutral)	•
Display Line Path Impedance	•
Display Neutral Path Impedance	•
Display Earth Path Impedance	•
Display Prospective Short Circuit L-N	•
Display Prospective Short Circuit L-E	•
Re-scroll Through Previous Results	•
Bat. OK / Low Battery Indicator	•
Scroll Through Previous Results	•
Auto-Off Function	•
Test Leads Compartment In The Case	•
Retractable Handle	•
Color Coded Test Leads	•
Display Voltage Line to Earth	•
Two wire operation Line to Earth possible	•
Strap and Battery Supplied	•
Very Low Consumption	•

Specifications are subject to change without notice.