CPOL3

Application Note

Manual version: ENU 1269 30 01

The product information, specifications, and technical data embodied in this manual represent the technical status at the time of writing and are subject to change without prior notice.

We have done our best to ensure that the information given in this manual is useful, accurate, up-to-date, and reliable. However, OMICRON does not assume responsibility for any inaccuracies which may be present.

The user is responsible for every application that makes use of an OMICRON product.

OMICRON translates this manual from the source language English into a number of other languages. Any translation of this manual is done for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this manual shall govern.

Table of contents

1 About this document 4
2 Safety instructions 5
3 Application examples 6
3.1 Testing CT wiring 6
3.2 Testing VT wiring 10
3.3 CT circuits with common return wire 12
3.4 Long parallel wires: Signal coupling 14
3.5 Self-supplied relays 17
Support 18

1 About this document

This document provides information on different application examples for the *CPOL3*. You can find further application examples in the knowledge library of the OMICRON Customer Portal. Check the knowledge library regularly for new or updated application examples.

Refer to the related User Manual for detailed information about this product and/or instructions on how to use this product properly and efficiently.

This document is to be supplemented by existing national safety standards for accident prevention and environmental protection.

2 Safety instructions

This Application Note may only be used in conjunction with the *CPOL3* User Manual that contains all safety instructions. The user is fully responsible for any application that makes use of OMICRON products.

Instructions are always characterized by a ▶ symbol, even if they are included in a safety instruction.

▶ Before you get started with this Application Note, carefully read and understand the *CPOL3* User Manual.

▶ Carefully read and understand the content of this Application Note as well as the manuals for the systems involved before operating them.

▶ Contact OMICRON Support (see section Support (page 18)) if you have any questions or doubts regarding the safety or operating instructions.

▶ Follow each instruction listed in the manuals, especially the safety instructions, since this is the only way to avoid the danger that can occur when working on high voltage or high current systems.

▶ Only use the equipment according to its intended purpose to guarantee safe operation.

▶ Before starting a test always make sure that the test signals are suitable for the system that you're testing.

Only experienced and competent professionals that are trained for working in high voltage or high current environments may implement this Application Note. The following qualifications are also required:

- Authorization for working in environments involving energy generation, transmission, or distribution, and familiarity with the approved operating practices for such environments.
- Familiarity with the five safety rules.
- Knowledgeable and proficient when working with OMICRON test sets and the *CPOL3*.

3 Application examples

3.1 Testing CT wiring

Injecting current

⚠ WARNING

Death or severe injury due to electrical shock possible

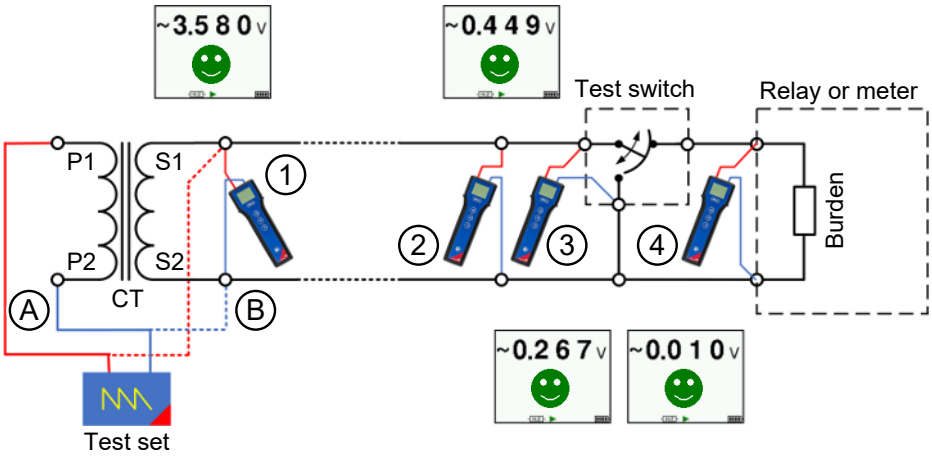
- ▶ Before injecting current, make sure that the CT taps on all cores are closed (either connected or short-circuited).
- ▶ To inject current, always follow all safety instructions in the information for use of the test set in use.

You can inject the test current on the primary side (A, solid line) or secondary side (B, dashed line) of a current transformer (CT) using an OMICRON test set (see figures in the following subsections for reference). Follow the instructions and observe the safety information in the applicable user manuals.

When using primary injection (A), select a primary test current at or below the rated current. A resulting secondary current of about 20 mA is sufficient for a wiring and polarity check.

When using secondary injection (B), we recommend using the rated secondary current (for example, 1 A or 5 A) as test current. This allows you to measure the burden voltage at the rated current.

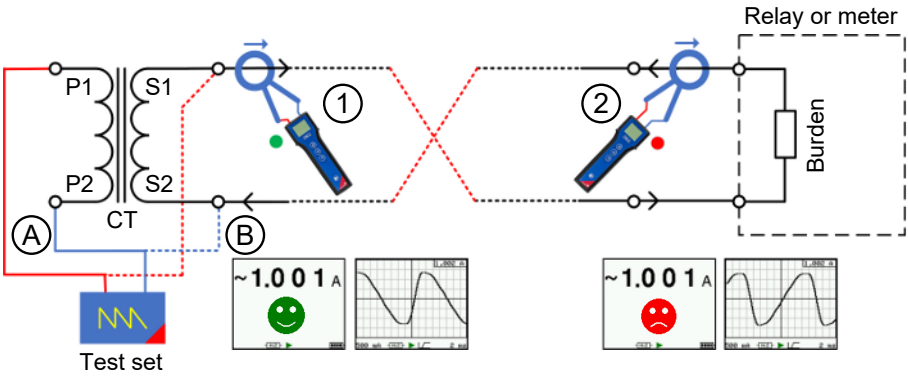
Testing CT wiring by measuring the voltage



You can check the polarity by measuring the voltage at the current path on different locations: from the CT (1) via terminal blocks (2) and/or test switches (3) to the relay or meter (4).

If you measure the voltage closer to the burden, the loop resistance is smaller. Therefore, the resulting voltage is smaller. So, the voltage falls from (1) to (4), which allows you to check all terminal blocks for the correct sequence.

Testing CT wiring by measuring the current with a current clamp



You can use a current clamp together with the *CPOL3* as an alternative method to check the wiring. Refer to the *CPOL3* User Manual, section **Settings menu**, for information on how to configure the ratio of the current clamp in use.

If the current flows in the same direction as the direction arrow on the current clamp, the *CPOL3* detects a correct polarity and shows a happy green face (1). The correct current flow leads from the red output of the test set to the black output of the test set (like plus to minus if it was DC).

If the actual current flow does not match the direction of the direction arrow on the current clamp, the *CPOL3* detects a wrong polarity and shows a sad red face (2).

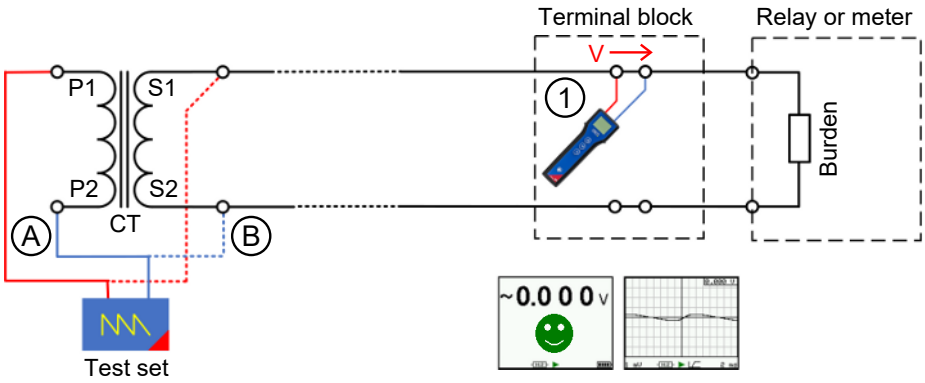
Measurement accuracy

The measurement accuracy when measuring currents significantly depends on the accuracy of the current clamp in use. Check the information for use of the current clamp for details.

Zeroing the current clamp

Some current clamps have a zero adjustment function. You need to perform the zero adjustment before using the current clamp with the *CPOL3*. Otherwise, the polarity may not be detected. For information on how to enable zero adjustment function, refer to the instructions for use of your current clamp.

Testing CT wiring by measuring the voltage drop on a terminal block



Another possibility to check the polarity is to measure the voltage drop (shown as V in the figure above) via a terminal block. The amplitude of this voltage drop depends on the current and the resistance of the terminal block. Therefore, this indirectly measures the current flow. Because the resistance is usually not well defined, the meter reading is not meaningful in this case. However, you can easily detect the polarity.

Note that this method typically requires a secondary current of about 1 A or above to cause a detectable potential difference, depending on the resistance of the terminal block. If the secondary current is below, use a current clamp as described in the previous example.

If the test current is small, it can happen that the voltage measured via the terminal block is below 1 mV. In this case, the *CPOL3* will show ~ 0.000 V. But it can still detect the polarity if the voltage is about ~ 100 µV. In such situations, you can switch to the **Oscilloscope** test mode to display the waveform of the polarity check signal (see figure above).

3.2 Testing VT wiring

Injecting voltage

⚠ WARNING

Death or severe injury due to explosion possible

The voltage transformer (VT) can explode when it is short-circuited while it is in service.

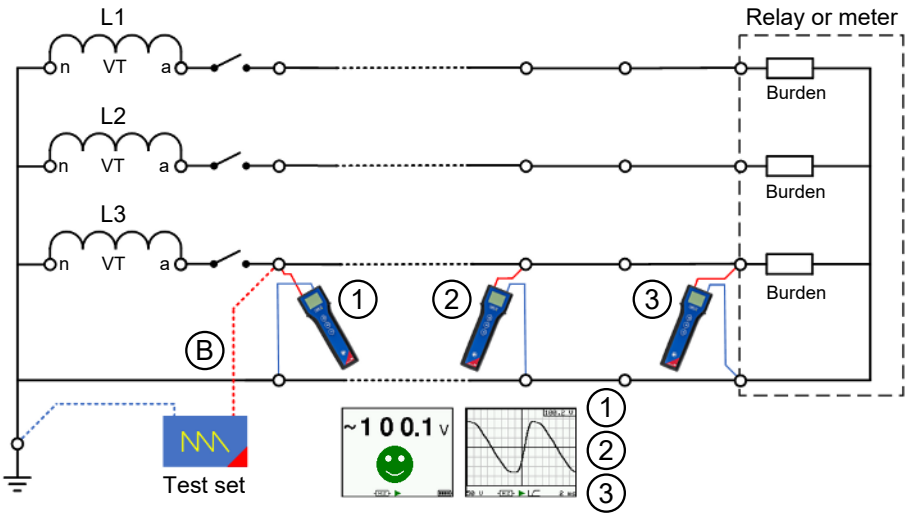
- Ensure that the VT is not in service during the injection of signals on the secondary side, and ensure that the primary side is safely disconnected.
  — or —
- Do not inject signals if it is not possible to open the fuse/miniature circuit breaker (MCB). Before injecting voltage on the secondary side of the VT, make sure that the fuse/MCB on the secondary side of the VT is open and that you inject the voltage on the burden side of the fuse/MCB.

You can inject the test voltage on the secondary side (B) of a voltage transformer (VT) using an OMICRON test set (see figures in the following subsections for reference). Follow the instructions and observe the safety information in the applicable user manuals.

Depending on the wiring of the primary side, it might also be possible to inject the voltage on the primary side of the VT. Refer to the user manual of the test set in use to check if this is possible and which safety measures are required.

Some test sets support accessories to generate a higher voltage for testing VT wiring with primary injection. For more information refer to the product brochure or ordering information of the test set.

Testing VT wiring by measuring the voltage



You can check the polarity by measuring the voltage at different locations on the VT path: from the VT (1) via terminal blocks (2) to the relay or meter (3).

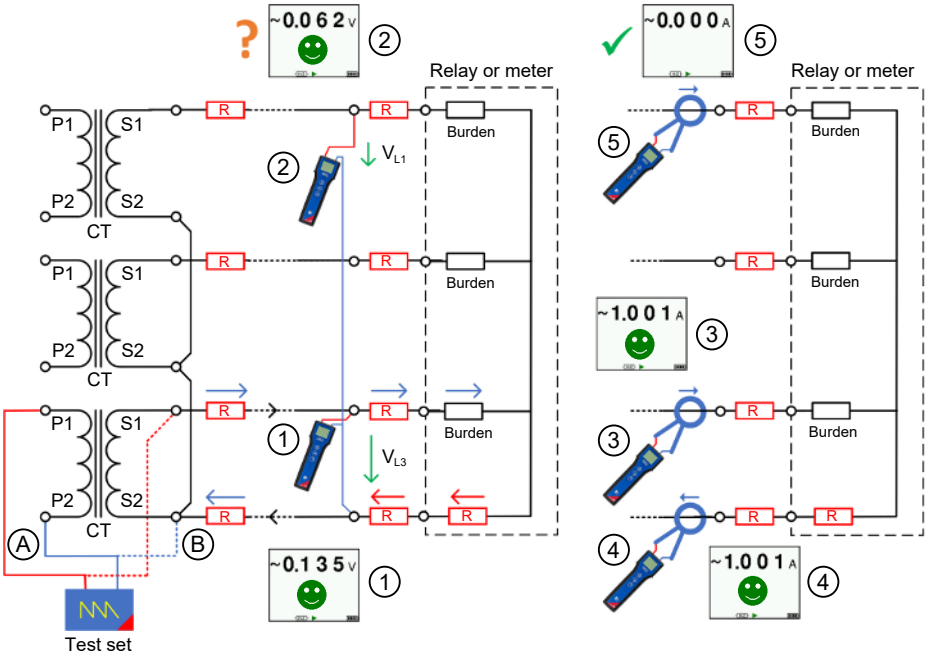
Due to the burden that is usually within the MΩ range, it is not possible to check the polarity across a terminal block or by using a current clamp. Furthermore, the voltages measured at different points will be virtually the same.

3.3 CT circuits with common return wire

⚠ WARNING

Death or severe injury due to electrical shock possible

- Before injecting current, make sure that the CT taps on all cores are closed (either connected or short-circuited).
- To inject current, always follow all safety instructions in the information for use of the test set in use.



CT secondary circuits can either use a separate return wire on each phase or a common return wire for all phases.

If you inject a test current into a system with a common return wire, the resistance of the wire (shown as R in the figure) and terminals causes a voltage drop on the phase wire and on the common return wire (blue and red voltage arrows in the figure).

The voltage and polarity on the phase under test (phase 3) can be measured correctly (V_{L3} at test point (1) in the figure). However, the voltage drop on a part of the common wire (red voltage arrows in the figure) also causes a potential difference on the terminal blocks of phase 1 (V_{L1} at test point (2) in the figure). Therefore, the *CPOL3* displays a voltage and polarity although no readings on this phase are expected. This could easily lead to misinterpretations of the readings.

The potential difference on the other phases is usually much smaller than the one on the phase under test (for example, less than half of the voltage if measured close to the meter/relay).

Possible solutions

- Solution 1:

  Use the *CPOL3* to measure all three phases. One should be significantly higher than the other two. This is the correct phase.

- Solution 2:

  A better solution would be to use a current clamp and measure the current instead of the voltage. In this case, the voltage drop has no impact on the measurement results. The current only flows on the phase under test (3) and returns on the common wire (4). Because the impedance of the unused CTs is usually very high, virtually no current flows on the other phases (5).

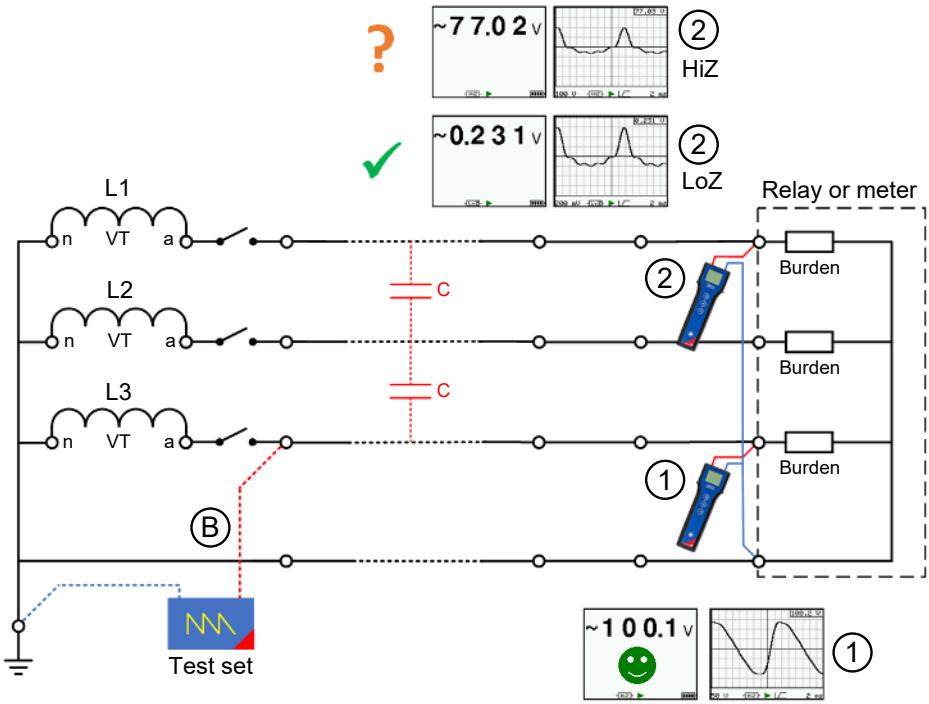
3.4 Long parallel wires: Signal coupling

⚠ WARNING

Death or severe injury due to explosion possible

The voltage transformer (VT) can explode when it is short-circuited while it is in service.

- ▶ Ensure that the VT is not in service during the injection of signals on the secondary side, and ensure that the primary side is safely disconnected.
  — or —
- ▶ Do not inject signals if it is not possible to open the fuse/miniature circuit breaker (MCB). Before injecting voltage on the secondary side of the VT, make sure that the fuse/MCB on the secondary side of the VT is open and that you inject the voltage on the burden side of the fuse/MCB.



A secondary circuit can have a length of 100 m (300 ft) or more. On long parallel wires, the resulting coupling capacity C (red in the figure above) can come into the range of 1 nF and above. The resistance of the burden in the relay/meter and the coupling capacity C forms a capacitive/resistive voltage divider. This is the reason for the coupling of the phase under test (phase 3 in the figure above) to the other two phases.

When you are using the *CPOL3* to measure on the phase under test, the correct voltage and polarity is measured (1). On the other phases, the coupled signal might cause confusion or lead to wrong interpretations (2). There might even be a rather high voltage reading on the VT circuit.

This effect is not relevant on CT circuits, because the current input resistance of the relay or meter is usually very low (a few Ohm or below). Therefore, there are no relevant coupling effects on CT circuits.

Possible solution

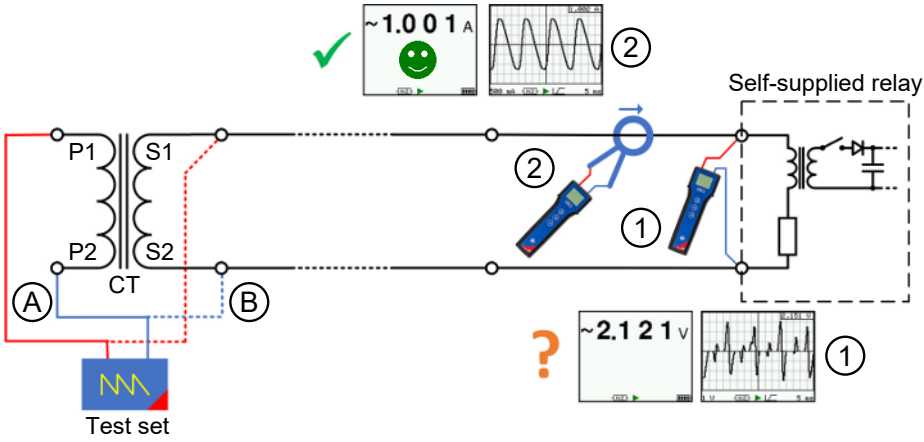
Enable the **LoZ** mode on the *CPOL3*. This reduces the input resistance to a low value of about 3 kΩ. The lower resistance significantly reduces the voltage of the coupled signal (see "(2) HiZ" and "(2) LoZ" in the figure). This may help to distinguish between the correct and coupled signals.

3.5 Self-supplied relays

⚠ WARNING

Death or severe injury due to electrical shock possible

- ▶ Before injecting current, make sure that the CT taps on all cores are closed (either connected or short-circuited).
- ▶ To inject current, always follow all safety instructions in the information for use of the test set in use.



Self-supplied relays often use switched-mode power supplies that can distort the voltage on the terminals (1). This happens especially with low test currents. The higher the current amplitude, the lower are the voltage distortions. The *CPOL3* might not be able to detect the polarity if you are measuring the voltage (1).

Possible solution

Use a current clamp and measure the current instead of the voltage. The current is not distorted and can be used to detect the polarity (2).

Support

When you are working with our products, we want to provide you with the greatest possible benefits. If you need any support, we are here to assist you.

OMICRON Support – get in touch

omicronenergy.com/support

At our support hotline, you can reach well-educated technicians for all of your questions.

Make use of our 24/7 hotlines:

Americas: +1 713 830-4660 or +1 800-OMICRON

Asia-Pacific: +852 3767 5500

Europe / Middle East / Africa: +43 59495 4444

Additionally, you can find the service center or sales partner closest to you at omicronenergy.com.

OMICRON Customer Portal – stay informed

my.omicronenergy.com

Browse through the knowledge library and find manuals, application notes, conference papers, and much more.

Download the latest software updates and learn about upcoming events.

OMICRON Academy – learn more

omicronenergy.com/academy

Learn more about your product in one of the training courses offered by the OMICRON Academy.

UK importer:
OMICRON electronics UK Limited
Staples Close
Redhill Business Park
Stafford
ST16 1WQ
United Kingdom

Manufacturer:
OMICRON electronics GmbH
Oberes Ried 1
6833 Klaus
Austria

ENU 1269 30 01