



CT Testing Guide



PARTNERS IN
POWER

About This Guide

CT testing proves that a current transformer has the ratio and polarity on its nameplate, a healthy magnetic core and sound secondary insulation, and that its secondary circuit will carry the current to the relay or meter as designed. This guide covers the field tests, the voltages applied to the secondary, the safety framework around an energised CT and how to judge a result.

What CT Testing Is

A set of low energy tests made from the secondary terminals of a de-energised current transformer: ratio, polarity, excitation (knee point) curve, winding resistance, burden and insulation resistance. Primary injection then proves the whole circuit through to the relay.

When It Is Used

At commissioning of every new CT, at the asset owner's routine interval, after any work on the CT or its secondary circuit, and after a heavy fault that may have magnetised the core.

Why It Matters

A CT with the wrong tap, reversed polarity or a saturated core gives the relay a current that is not the one in the primary. The protection then trips when it should not, or fails to trip when it must. The fault is invisible until the day it is needed, unless a test finds it first.

Guide at a Glance

Tests

Ratio, polarity, excitation curve and knee point, winding resistance, burden, secondary insulation resistance, primary injection.

Standards

AS 61869.2:2021 for the CT classes and limits; IEEE C57.13.1-2017 for the field methods; the asset owner's testing standard for what is tested.

Secondary Test Voltage

Below the knee point for ratio; above it only for the excitation readings (IEEE C57.13.1, cl 12.1).

Judged Against

The nameplate, the class limits in AS 61869.2 Table 201 or 205, the manufacturer's curve and the CT's own history.

Test Sets

OMICRON CT Analyser for secondary tests; CPC 100 or CPX 200 for primary injection.



Need CTs tested, or the test set to do it? Megavar commissions instrument transformers across Australia and hires every instrument in this guide.

Why Test Current Transformers?

CT Testing in Four Numbers

1 M Ω

Generally accepted minimum secondary insulation resistance (IEEE C57.13.1, Clause 10)

10% / 50%

Knee point: 10% more voltage gives 50% more exciting current (AS 61869.2, cl 3.4.215)

3%

Turns ratio deviation from nameplate that is investigated (USBR FIST 3-8, 5.5)

60%

Of knee point voltage needed to bring remanence below 10% (IEEE C37.110, 4.6)

Why the CT Has to Be Right

The Relay Sees Only the Secondary

Every protection and metering decision is made on the CT secondary current. A wrong tap, reversed polarity or a core that saturates early gives the relay a current that is not the one in the primary.

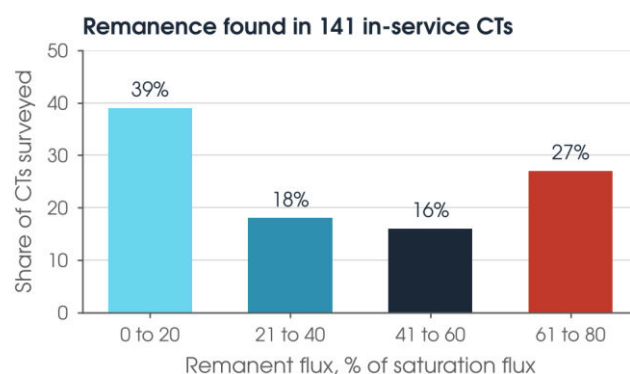
Two Ways to Fail

A differential or earth fault scheme trips on load when one CT in the group is wrong; a feeder relay under-reaches when its CT saturates. TasNetworks' testing standard notes that transformer differential schemes often reach commissioning with circuit errors.

A Magnetised Core Fails Early

DC in the primary, or any DC test, leaves remanence. IEEE C37.110-2023 (cl 4.6.1) shows a C800 CT reaching saturation in 25 ms with no remanence and 5 ms with 75%. The chart shows how common remanence is.

Remanence in Service CTs



Source: IEEE C37.110-2023, Table C.1

More than a quarter of the CTs surveyed held remanence above 60% of saturation flux. It stays until the core is demagnetised.

When to Test



Where Is It Used?

CTs Tested

Current transformer	What a bad result points to	Key tests
Bushing CTs in transformers and circuit breakers	Wrong tap selected, lead polarity crossed, core magnetised, coupling between cores	Ratio, polarity, excitation on every core and tap in use
Free-standing HV CTs, oil or SF6	Moisture in the main insulation, lowered knee point, shorted turn	Excitation, winding resistance, capacitance and tan delta on the HV insulation
Switchgear ring and wound primary CTs	Open or shorted secondary, wrong ratio for the setting, undersized for the burden	Ratio, polarity, burden
Metering CTs, classes 0.2S and 0.5S	Burden outside the 25% to 100% band the accuracy class is specified for	Ratio error and phase displacement at the connected burden
Protection CTs, classes 5P, 10P, PX and PXR	Knee point e.m.f. or exciting current outside the nameplate value, remanence	Excitation curve, winding resistance, burden
Core balance and neutral CTs	Cable sheath earth passed back through the window, polarity reversed	Polarity, primary injection through the window

Which Tests Apply

AS 61869.2:2021

Defines the classes and their limits: ratio error and phase displacement for measuring classes (Table 201), composite error for 5P and 10P (Table 205), knee point e.m.f. and exciting current for PX and PXR (cl 5.6.202.4).

IEEE C57.13.1-2017

The field test guide: ratio, polarity, insulation resistance, winding resistance, excitation, admittance and burden (Clause 6), with the methods for each.

The Asset Owner's Standard

Sets what is tested and when. TasNetworks requires newly installed CTs to be tested for polarity (cl 12.2) and the ratio of each core proven by primary injection (cl 13.3).

Our Recommendation

Ratio, polarity, excitation, winding resistance, burden and insulation resistance on every core at commissioning, then primary injection through the complete circuit. The asset owner's specification overrides this.

Test Voltage on the Secondary

Ratio Test

Keep the applied voltage below the knee point so the core stays linear; OMICRON recommends 50% to 75% of the knee point voltage for the ratio test.

Excitation Test

The curve has to pass through the knee, so the voltage goes above it, but only for as long as the readings take (IEEE C57.13.1, cl 12.1). USBR FIST 3-8 limits the exciting current to twice rated secondary current and the secondary voltage to 1,500 V.

Variable Frequency

A test set can reach the same flux at a lower voltage by lowering the frequency, which is how knee points of several kilovolts are measured safely (IEEE C57.13.1, cl 12.2.3).

Good to Know

Test the full winding where you can. A tap is compared with the manufacturer's curve and rating for that tap; the IEEE C rating applies to the full winding unless otherwise specified (IEEE C57.13, cl 6.4.2).

How Does It Work?

Exciting Current Drives the Error

Ampere-Turn Balance

Primary ampere-turns supply the secondary ampere-turns plus the core's exciting current. Exciting current causes the ratio and phase errors, and is small until the core approaches saturation.

The Excitation Curve

Voltage is applied to the secondary with the primary open and the exciting current recorded at each step. Plotted on log-log axes the curve is steep below the knee and nearly flat above it.

Two Knee Point Definitions

AS 61869.2 (cl 3.4.215) defines the knee as the voltage where a 10% rise gives 50% more exciting current. IEEE C57.13 (cl 6.10.2) uses the 45° tangent on log-log axes. The IEC knee reads about 20% to 25% higher on the same CT (IEEE C37.110, cl 4.3.2).

Ratio and Polarity From the Same Set-Up

The voltage induced on the open primary gives the turns ratio, and its phase against the applied voltage gives polarity: near 0° correct, near 180° reversed (IEEE C57.13.1, cl 9.4.2).

Connection Rules

Primary Open

The primary conductor must be open-circuited for the excitation test, with no closed loop through the breaker, earth switch or an adjacent CT (IEEE C37.110, cl 4.2).

Other Cores Shorted

Every other core on the same primary is shorted or left on its burden. OMICRON measured turns ratio errors up to 3.5% on transformer bushing CTs when the windings around them were left open.

Demagnetise First

A magnetised core distorts the whole curve. Demagnetise before the excitation test and after any DC test (IEEE C57.13.1, cl 5.1).

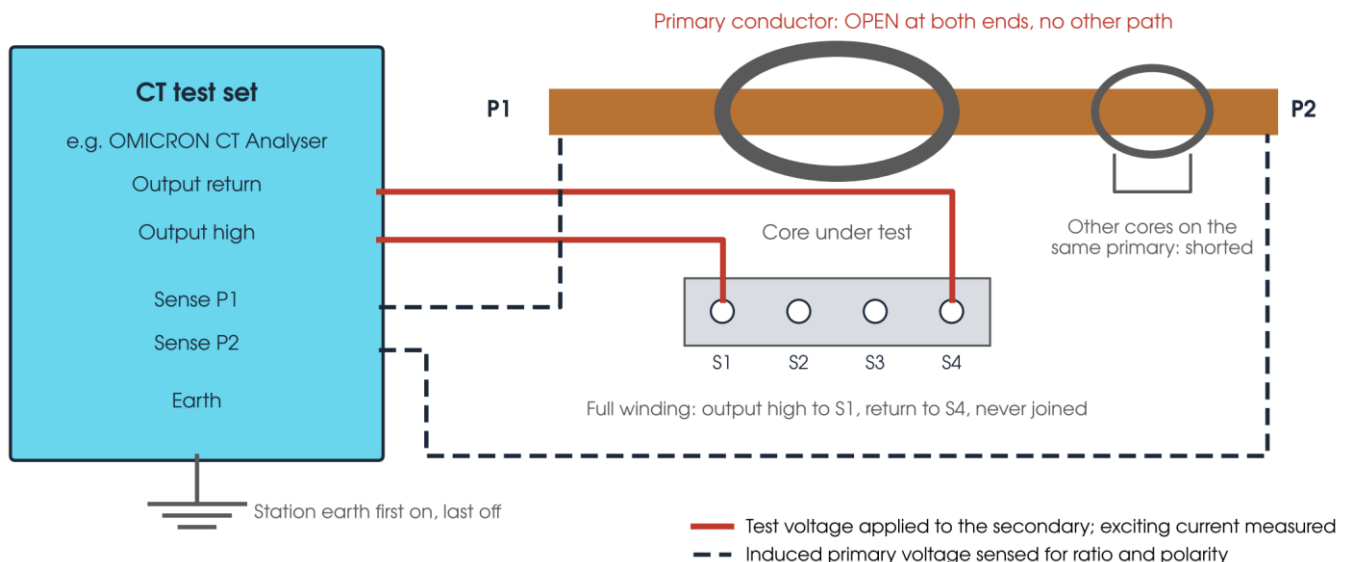
Average-Responding Voltmeter

Manufacturers' curves are taken with an average-responding meter calibrated in rms; an rms meter reads more than 10% high above the knee (IEEE C57.13.1, Annex B).

Good to Know

Name the knee point definition with every value. A PX knee point e.m.f. and a C class knee are not the same number.

Secondary Injection Connection



One set-up for excitation, ratio and polarity. The test set drives the full secondary winding with the primary open and senses the induced primary voltage.

How Do I Set Up Safely?

Permits, Isolation and Earthing

1 Access Permit

Work on CTs and their secondary circuits only under the asset owner's safety rules and the access permit. Revenue metering CTs also need the metering provider (TasNetworks, cl 3.6).

2 Primary Isolated, Proved Dead, Earthed

Confirm it at the plant with the permit issuer. Open the disconnectors before any connection is made to a breaker bushing CT (IEEE C57.13.1, cl 9.4.3).

3 Secondary Isolated on a Checklist

List every CT link, trip and breaker fail isolation on an alteration and isolation checklist, and restore from the same list (TasNetworks, cl 6.4).

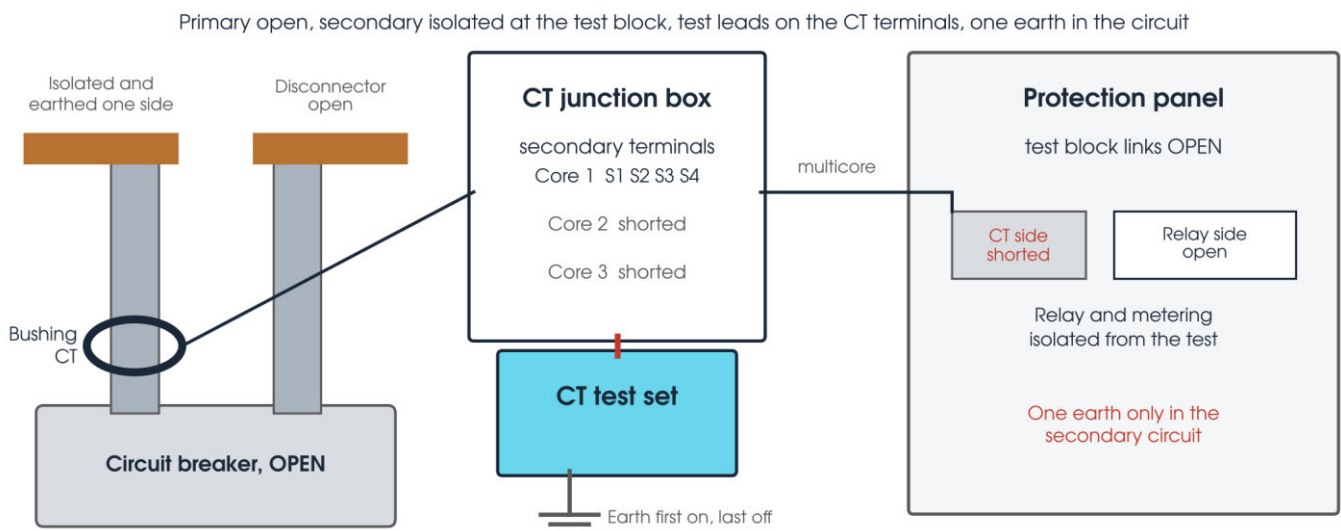
4 Earth the Test Set First

Connect the test set to the station earth before any other lead, and remove it last.

Who Should Test

Competent, authorised testing personnel. IEEE C57.13.1 (Clause 5) restricts the tests to experienced personnel familiar with the hazards of the set-ups.

Set-Up on a Breaker Bushing CT



Primary open and earthed, secondary isolated at the test block with the CT side shorted, one earth in the circuit.

Important

This guide describes general practice for competent HV testing personnel. It is not a work procedure. Work under the asset owner's safety rules, the access permit and a site-specific safe work method statement. Manufacturer and asset owner criteria take precedence over the general guidance here.

CT-Specific Hazards

Never Open an Energised CT Secondary

An open-circuited CT in service, or during injection, develops voltages that can be lethal, damage the insulation and flash over (TasNetworks, cl 3.5). Short the CT side at the test block before the relay side is opened.

DC Leaves Remanence

A winding resistance or DC polarity test magnetises the core. Demagnetise after any DC test, and before returning the CT to service (IEEE C57.13.1, cl 9.1).

Voltage on Disconnection

Breaking a DC source from a CT winding generates a dangerous voltage; parallel a resistor of about the winding resistance across it first (IEEE C57.13.1, cl 9.1).

One Earth Only

A second earth on the secondary circuit forms a loop with the first. Doble reports 2.08 A induced through a relay by adjacent lines, which tripped a 161 kV breaker.

How Do I Make the Measurement?

Seven Steps



Steps 1 to 4

1 Isolate and Short

With the primary isolated under the permit, short and verify the CT side at the test block before opening the relay and metering side. Remove the circuit earth only for the insulation test, checking for a second earth (USBR FIST 3-8, cl 5.2).

2 Insulation Resistance

Secondary winding and circuit to earth at 500 V DC (USBR FIST 3-8, cl 5.3) or 1 kV DC (AS 61869.1, cl 5.4.5.3). Relays stay disconnected unless they are rated for the test voltage.

3 Winding Resistance

Four-wire DC measurement at the short-circuiting terminal block. Record the temperature; the standard value is corrected to 75 °C (AS 61869.2, cl 7.3.201).

4 Demagnetise and Excite

Demagnetise, then raise the secondary voltage in steps through the knee, recording the exciting current. Take the readings near the knee closely (IEEE C57.13.1, cl 12.2.1).

Common Mistakes

Tap Against the Wrong Curve

A tap compared with the full winding curve reads low and looks like a fault. Use the curve for that tap.

Other Cores Left Open

Turns ratio errors up to 3.5% on transformer bushing CTs (OMICRON).

Primary Loop Closed

A closed breaker or earth switch is a shorted turn through the window; the curve collapses.

Core Not Demagnetised

After a DC test the curve is distorted and the CT goes back to service magnetised.

Steps 5 to 7

5 Ratio and Polarity

Apply a voltage below the knee to the full winding and read the induced primary voltage and its phase. Check every tap in use against the full winding.

6 Burden

Measure the connected burden from the CT terminals with the CT disconnected, at or near rated secondary current, and compare with the nameplate output (IEEE C57.13.1, Clause 15).

7 Demagnetise and Restore

Demagnetise after the last test. Restore every link from the checklist, replace the circuit earth, then remove the test set earth last.

Good to Know

Run the winding resistance test before the excitation test; the excitation test demagnetises the core afterwards (Doble, 2022).

More Common Mistakes

RMS Meter Above the Knee

Reads more than 10% high and triggers an investigation of a healthy CT (IEEE C57.13.1, Annex B).

Knee Definitions Mixed

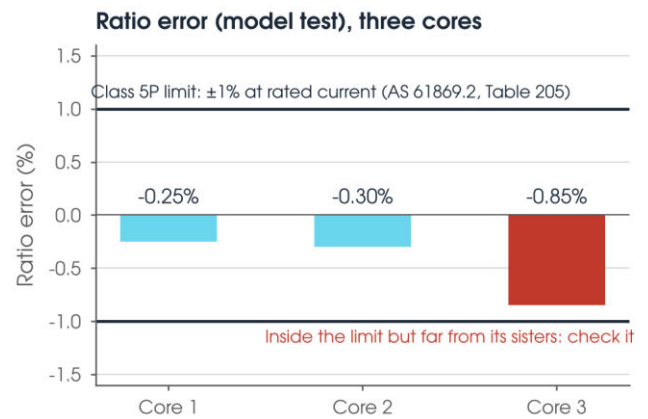
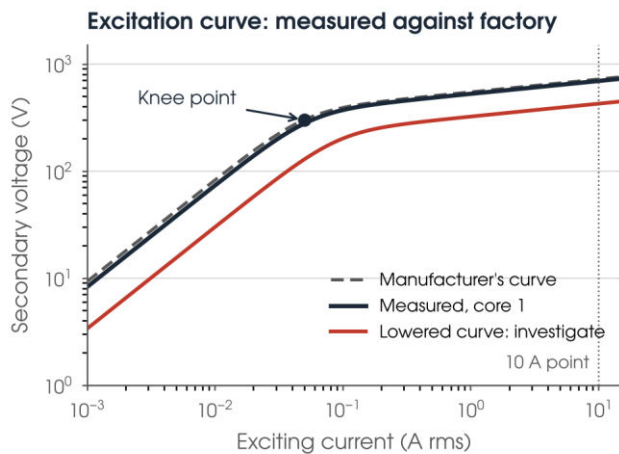
An IEC knee compared with an IEEE curve shows a 20% to 25% difference that is not real.

Links Not Restored From the Checklist

A CT left shorted at the test block, or a trip left isolated, when the bay returns to service.

How Do I Read the Result?

Excitation Curve and Ratio Error



Illustrative values

Core 1 follows the factory curve. The lowered red curve is below 95% of factory voltage above the knee: investigate. Core 3's ratio error is inside $\pm 1\%$ but far from its sisters: check it.

Comparing the Result

The Nameplate

Ratio, class, rated output or burden, and for PX and PXR the knee point e.m.f. and exciting current. The voltage ratio test verifies turns ratio, tap and polarity, not accuracy class (IEEE C57.13.1, cl 6.1).

The Class Limits

Class 5P: ratio error $\pm 1\%$ and phase displacement ± 60 minutes at rated current and burden, shown by a current test or a validated model test; 10P: $\pm 3\%$ (AS 61869.2, Table 205). Class 0.5: $\pm 0.5\%$ at 100% current (Table 201). PX: turns ratio error 0.25%; PXR: 1% (cl 5.6.202.4).

The Factory Curve

Exciting current below the knee within 125% of the curve value, and voltage above the knee not less than 95% of it (IEEE C57.13-2016, Figure 6). A C class CT must give more than its class voltage at 10 A exciting current (IEEE C57.13.1, cl 12.3).

Its Own History

A slight lowering over time with the same shape is normal; a lowered knee, a dip or a spike is not (IEEE C57.13.1, cl 12.3).

What a Bad Result Looks Like

Ratio Out by a Whole Step

The wrong tap is selected, or the leads are on the wrong terminals.

Polarity Near 180°

S1 and S2 are crossed, or P1 and P2 are. Check the drawing before touching the CT.

Lowered Knee or Exciting Current Sine Wave

A shorted turn; a clean sine wave above the knee is a fully shorted core (IEEE C57.13.1, cl 12.3).

Winding Resistance High

A bad joint in the CT or the leads. Bushing CTs typically run 2 to 3 m Ω per turn (IEEE C57.13.1, Clause 11).

Insulation Resistance Low

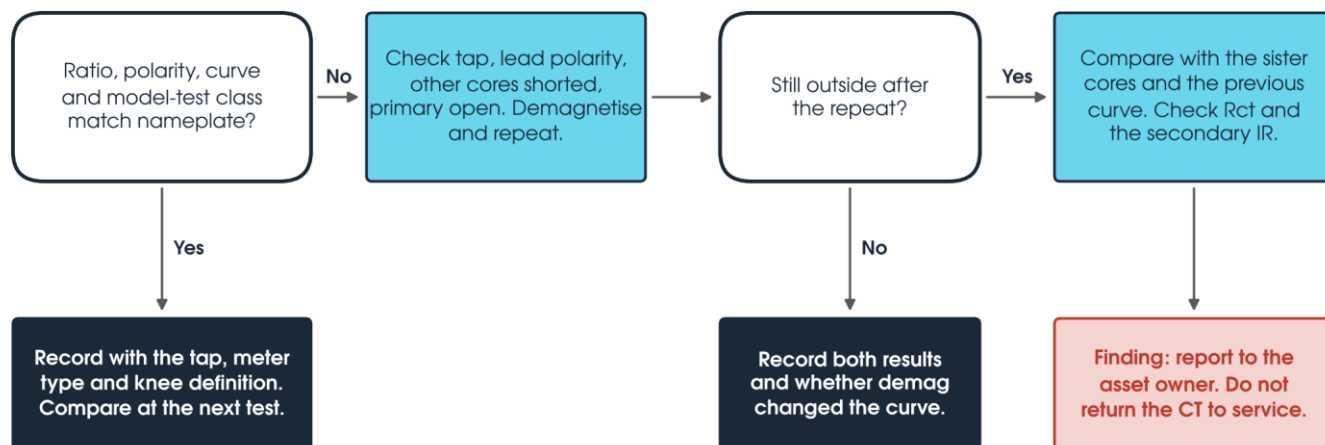
Moisture, most commonly on the terminal board; dry out and retest before dismantling (IEEE C57.13.1, Clause 10).

Burden Above Rating

The CT saturates earlier than the protection study assumed.

Is My Result OK?

Decision Path



Correcting Winding Resistance

Secondary winding resistance is specified at 75 °C (AS 61869.2, cl 7.3.201). Correct the measured value before comparing it (constant 234.5 for copper, IEEE C57.12.90-2021, cl 5.2):

$$R_{75} = R_t \times (234.5 + 75) / (234.5 + T)$$

R_t is measured at winding temperature T (°C).

Worked Example

A 1200/5 core reads 0.610 Ω at 20 °C. At 75 °C it is $0.610 \times 309.5 / 254.5 = 0.742$ Ω. That 22% rise is temperature alone, and it is the 75 °C value that goes into a PX knee point check.

What to Report

For Each Core and Tap

Ratio, polarity, knee point voltage and exciting current with the definition used, winding resistance with temperature, burden and insulation resistance.

The Criteria Used

Nameplate values, the class limits applied, and the manufacturer's curve if one was available.

Conditions

Test voltage, frequency, meter type, tap connected, and whether the CT was demagnetised before and after.

Traceability

Test set model, serial number and calibration date, and the signed isolation checklist (TasNetworks, cl 6.2).

What About Primary Injection?

Why Inject the Primary

It Proves the Whole Circuit

Current through the CT primary reaches the relay only if the ratio, polarity, tap, terminal block and multicore are all right. TasNetworks requires it to prove the ratio of each core and the current in each conductor (cl 13.3).

What Secondary Tests Cannot See

A crossed phase, a wrong neutral or two cancelling polarity errors (TasNetworks, cl 12.2). Differential and restricted earth fault schemes must be proven by current through the transformer and its CTs before energising (cl 13.4).

Interpreting the Result

Ratio and Phase

Secondary current times nameplate ratio equals the injected current, in the phase injected and nowhere else. USBR FIST 3-8 investigates a ratio more than about 3% from the nameplate.

A Functional Check, Not Calibration

Reduced current confirms function; accuracy class is verified only at rated values or by a model-based test (OMICRON, 2025).

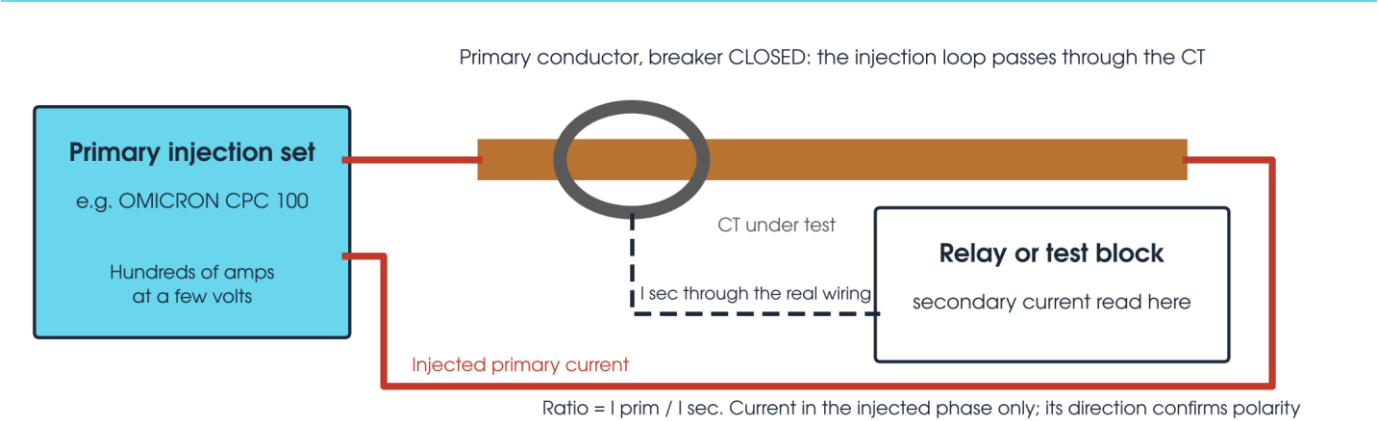
Multi-Core CTs

Every core carries the injected current at once: watch shorted circuits and short-time rated relays (TasNetworks, cl 13.2).

Good to Know

Read the current at the relay, not the junction box. The point of the test is everything in between.

Primary Injection Arrangement



Recommended Solutions		
Instrument	Method	Best used for
OMICRON CT Analyser	Secondary injection, model based	Ratio, polarity, excitation, winding resistance and burden, assessed to AS 61869 or IEEE C57.13
OMICRON CT SB2 switch box	Automatic tap switching	Multi-ratio and multi-core CTs in one run
OMICRON CPC 100	Primary injection to 800 A	Primary injection through the circuit to the relay; ratio and polarity
OMICRON CPX 200	Primary and secondary injection	CT and VT ratio in one set; HVX10 adds a 10 kV source
OMICRON CP TD1	Tan delta accessory for CPC 100	Capacitance and tan delta on the HV insulation of free-standing CTs
Megger MIT520 5 kV	Insulation resistance to 5 kV	Secondary winding and circuit insulation resistance

Every instrument is available calibrated, with leads, from Hobart, Launceston, Adelaide and Newcastle: [CT testing equipment hire](#).

Frequently Asked Questions

Common Questions

What is CT testing?

A set of field tests that prove a current transformer has its nameplate ratio and polarity, a healthy core and sound insulation, and delivers the right current to its relay or meter.

How many tests of CT?

Seven in this guide: ratio, polarity, excitation curve, winding resistance, burden, insulation resistance and primary injection. IEEE C57.13.1 also describes an admittance test for in-service CTs.

What is CT and PT testing?

The same checks applied to current and voltage (potential) transformers: ratio, polarity, insulation and burden. A VT is tested from its primary side, because its secondary must never be shorted and its primary must never be back-energised.

How to check CT and PT?

CT: from the secondary terminals of the isolated unit, then primary injection where required. VT: by the primary-side method in our VT testing guide; never with the CT secondary method.

Standards and References

AS 61869.1:2024, Instrument transformers, Part 1: General requirements.

AS 61869.2:2021 (Amd 1, 2022), Instrument transformers, Part 2: Additional requirements for current transformers.

IEEE Std C57.13-2016, Standard Requirements for Instrument Transformers.

IEEE Std C57.13.1-2017, Guide for Field Testing of Relaying Current Transformers.

IEEE Std C37.110-2023, Guide for the Application of Current Transformers Used for Protective Relaying Purposes.

IEEE Std C57.12.90-2021, Standard Test Code for Liquid-Immersed Transformers, clause 5.2.

TasNetworks, Secondary Equipment Testing Standard, 2021.

US Bureau of Reclamation, FIST 3-8, Field Test Procedures for Protective Relays and Associated Circuits, 2021.

OMICRON, Best Practices for Ratio Verification of Power Transformer CTs, NETA World, 2024; Diagnostic Testing of Instrument Transformers, 2025.

Doble, Field Test on Cascade Current Transformer, 2022; Current Transformer Doble Testing Tripping Upstream Breaker, 2024.

Safe Work Australia, model Code of Practice: Managing Electrical Risks in the Workplace.

More Questions

How to measure CT burden?

Disconnect the CT, drive rated secondary current into the connected circuit from the CT terminals and measure the voltage needed. Volts times amps is the burden in VA (IEEE C57.13.1, Clause 15).

What is the knee point voltage?

The secondary voltage at which the core begins to saturate. AS 61869.2 defines it as the point where 10% more voltage gives 50% more exciting current; IEEE C57.13 uses the 45° tangent on log-log axes.

How often should CTs be tested?

The asset owner's plan sets it. USBR FIST 3-8 gives an excitation test at commissioning and every 6 years, and a burden check after any change to the secondary circuit.

Does Megavar test as well as hire?

Yes. Our engineers commission CTs, VTs and protection schemes across Australia. Call 1300 730 499.

Hire or Have It Tested

Have It Tested

Megavar's engineers carry out [substation commissioning](#), [protection relay testing](#) and [transformer testing](#) from 11 kV distribution to 500 kV transmission.

Next Step

[Hire CT test sets](#)

[Book CT testing and commissioning](#)
[1300 730 499](#)

Hire: rentals@megavar.com.au

Testing: service@megavar.com.au



Speak to our team today

megavar.com.au



service@megavar.com.au

1300 730 499