



Secondary Isolation Guide



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About This Guide

Secondary isolation separates the protection, control and metering circuits under test from the circuits that stay in service. It is made at links, test blocks and terminals in the panel, and in relay software. This guide covers the principles: CT shorting, VT isolation, trip isolation, delineation and restoration. It is not a procedure.

What Secondary Isolation Is

Opening the CT, VT, trip, intertrip and signalling circuits of the scheme under test at defined points, in a set order, so the test cannot reach plant in service and the plant cannot reach the tester.

When It Is Used

For secondary injection, primary injection, CT and VT testing, circuit breaker testing, scheme commissioning and decommissioning, wherever other circuits in the panel stay live.

Why It Matters

A wrong isolation, or a wrong restoration, can trip plant in service, leave plant without protection, or expose a person to a dangerous voltage. The work is only as safe as the isolation.

Guide at a Glance

Two Rules

Never open circuit an in-service CT secondary. Never short circuit an in-service VT secondary.

Order

Trips, breaker fail and intertrips open first and restore last; CT and VT circuits in between.

The Record

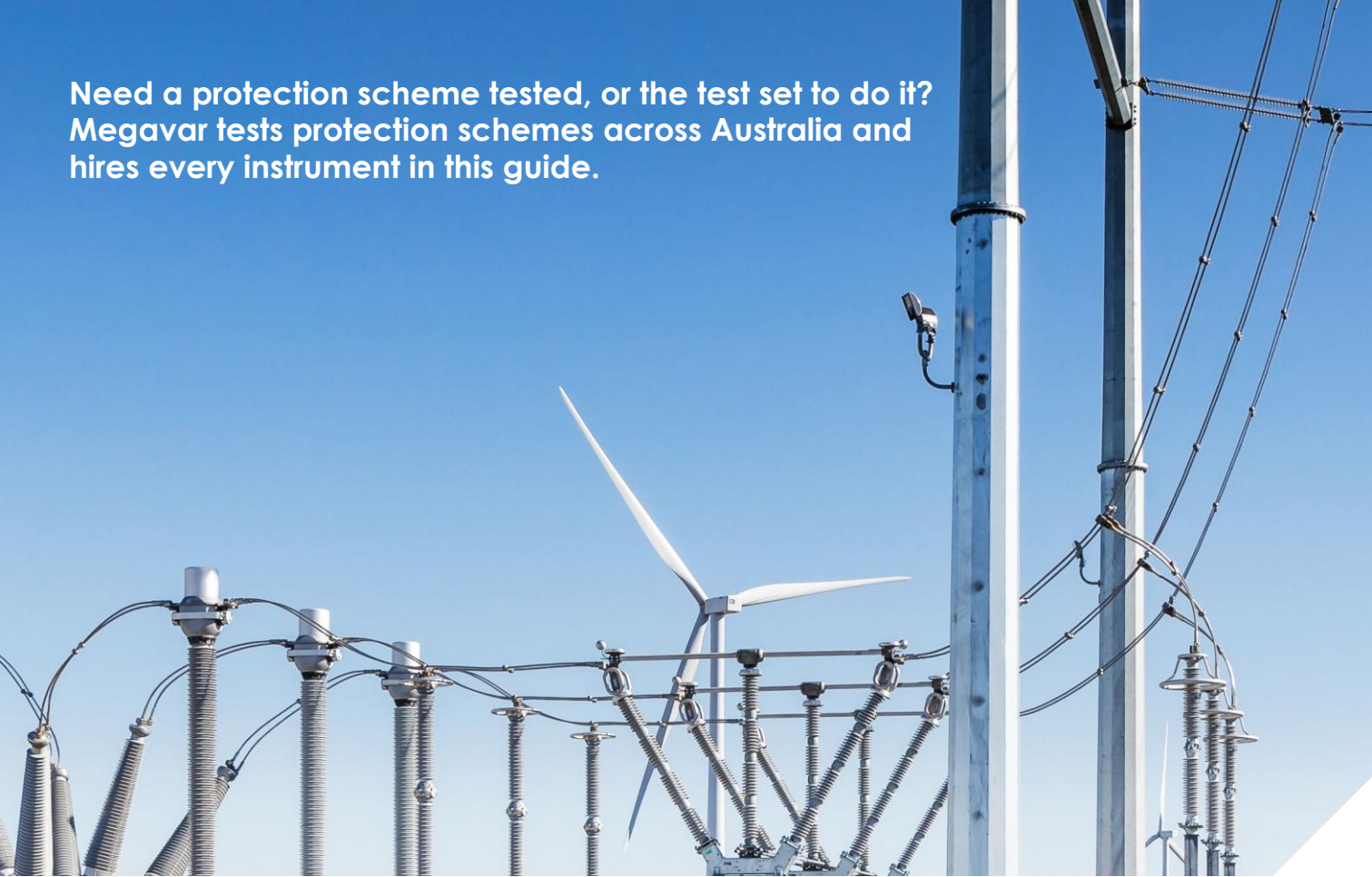
A written isolation table, checked by a second competent person before use.

Before a Trip Link Closes

Prove the trip contact is open.

Governed By

The network operator's or site's access and safety rules, which always take precedence.



Need a protection scheme tested, or the test set to do it?
Megavar tests protection schemes across Australia and
hires every instrument in this guide.

Why Isolate Secondary Circuits?

Secondary Isolation in Four Numbers

2 rules

Never open an in-service CT (IEEE C57.13, cl 6.7.1).
Never short an in-service VT.

3 circuits

Breaker fail, trips and intertrips: open first, restore last

3,500 V

Peak open circuit CT voltage above which a limiter is considered (IEEE C57.13)

2 people

One prepares the isolation table, a second competent person checks it

What Can Go Wrong

Plant Trips in Service

A trip, breaker fail or intertrip left connected lets a test trip a live breaker or another bay. A second earth can too: A 2024 Doble conference paper reports 161 kV breakers opened when CT secondaries were shorted and earthed at the CT for an insulation test, forming a loop with the panel earth.

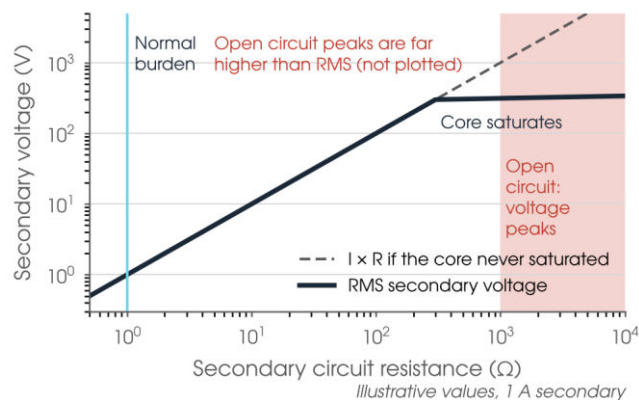
Plant Left Unprotected

A CT short or an isolation left on after the work leaves the bay back in service with a scheme that cannot see a fault.

A Dangerous Voltage

An in-service CT with its secondary opened drives its current into the open point and develops a dangerous voltage. IEEE C57.13-2016 (cl 6.7.1) states CTs should never be operated with the secondary open.

Why a CT Must Not Be Opened



The CT keeps forcing its current. As the burden rises the secondary voltage rises with it, until the core saturates and the voltage appears as high peaks.

When Isolation Is Needed



Where Is It Used?

Circuits Isolated, and the Principle for Each

Circuit	Principle	If it is wrong
CT secondary	Short the CT side first, then open the link; restore by closing the link, then removing the short	A dangerous voltage at the open point; CT damage
VT secondary	Open the link or fuse; never short it; never inject into it while connected to the VT	High current, blown VT fuses, voltage lost to every device on that supply; a back-energised VT primary
Trip and breaker fail	Open first, restore last; prove the contact open before the link is closed	A live breaker or adjacent bay trips
Intertrips and communications	Find out what the scheme does when communications are lost before isolating	The remote end trips, blocks or switches to backup
Software and IEC 61850 signals	A blocked trip or GOOSE signal is a trip isolation, made with the trips, once its effect on every subscriber is checked	A trip sent over the station bus while hardwired links are open
Alarms, SCADA and metering	Tell the control room; involve the metering provider for revenue metering	False alarms, or lost metering data

The Rules That Apply

The Access Rules First

The network operator's or site's safety rules and the access permit govern every isolation. Nothing in this guide relaxes them.

The Standards

IEEE C57.13-2016 (cl 6.7.1): CTs should never be operated with the secondary open. IEEE C57.13.1-2017 Annex A covers test switches, test plugs and multiple earths in CT circuits.

Competence

AS 2067 cl 2.1.1 requires testing and commissioning to be carried out by qualified and competent personnel.

Our Practice

A written isolation table, in the order the isolations will be made, checked by a second competent person before it is used.

Why the Order Matters

Trips Open First

With trip, breaker fail and intertrip circuits open, an operation of the scheme during the CT and VT work cannot reach plant through those circuits.

Restore in Reverse

CT and VT circuits are restored and the protection confirmed stable before any trip circuit is restored.

Shared Circuits

One CT or VT often feeds several schemes. Other schemes on the same circuit stay in service and need the same care.

Good to Know

Relay test mode alone is not an isolation. Physical outputs and GOOSE paths are isolated to the approved plan.

How Does It Work?

Where Circuits Are Isolated

Links and Terminals

Sliding or removable links in the panel terminal strips open one circuit at a time and are marked at the isolation point.

Test Blocks and Plugs

A test block can open several circuits when its cover is removed or a plug is inserted. What each does to every CT, VT and trip circuit is read from the drawings before it is touched.

Shorting Switches

A make before break switch shorts the CT side then opens the relay side. IEEE C57.13.1 (A.2.2) notes it does not earth the CT.

Relay Software

Elements, outputs and IEC 61850 signals blocked in the relay are recorded and removed like any other isolation.

The Two Instrument Transformer Rules

Why a CT Is Shorted First

A CT is a current source: its secondary current is set by the primary. A short gives that current a path, so the link can then be opened with next to no voltage across it.

Why a VT Is Never Shorted

A VT is a voltage source. A short on its secondary draws a high current, can blow the VT fuses or damage the VT, and removes the voltage from every device on that supply.

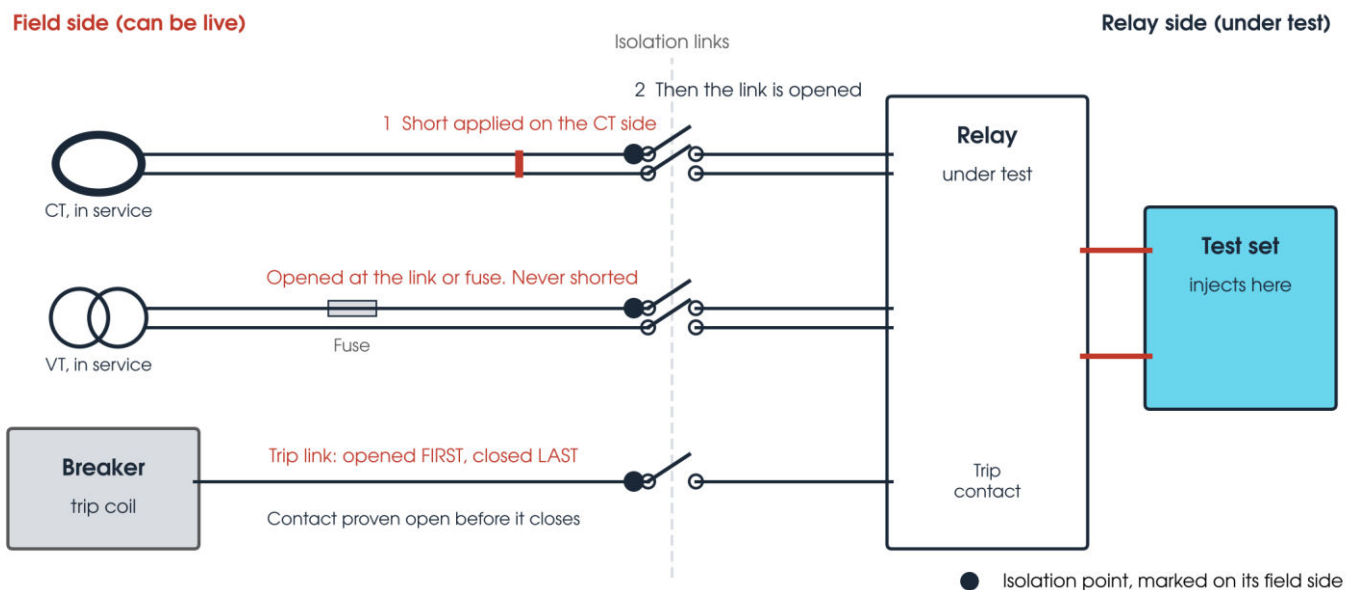
Why a VT Is Opened, Not Fed

With the VT link or fuse open, injected test voltage cannot reach the VT through that circuit and be stepped up onto its primary.

Good to Know

A CT wire in service reads about 0 V and still carries current. A meter reading does not make a CT wire safe to remove: the short goes on first.

CT, VT and Trip Isolation at the Panel



The CT is shorted on its own side before the link opens; the VT is opened, never shorted; the trip link opens first and closes last.

How Do I Set Up Safely?

Before the First Isolation

1 Permit and Control Room

Hold the access permit and tell the control room which protection will be out of service and for how long. Agree any outage of protection on in-service plant with the operator first.

2 Current Drawings

Write the isolation table from the current wiring and schematic diagrams, with their revisions recorded.

3 A Second Check

A second competent person checks the table before it is used. Where it cannot be done before site, it is still done on site before any isolation.

4 Walk Through and Record

Walk the panels with the table. Record existing isolations, unusual conditions and active alarms and LEDs before anything is touched.

Who Should Do It

Competent personnel (AS 2067, cl 2.1.1), authorised under the network operator's or site's rules.

Delineation and Hazards

Mark What Not to Touch

Panels, cubicles and terminal strips outside the work are marked as no-go zones; isolation points are marked on their field side, the side that can be live.

Multiple Earths

Removing a CT circuit earth with the primary energised can produce dangerous voltages by electrostatic coupling (IEEE C57.13.1, A.1).

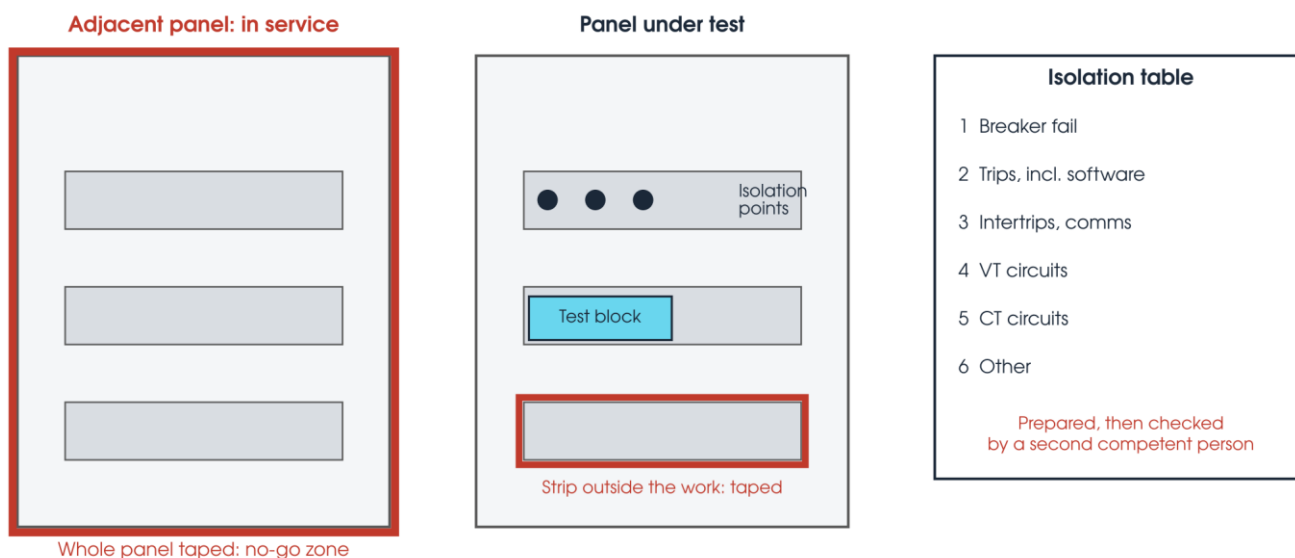
Shared CTs

One CT can feed several relays. One isolation can affect several schemes.

Communications

Losing a protection signalling channel can make a scheme trip, block or switch in backup protection.

Delineation at the Protection Panel



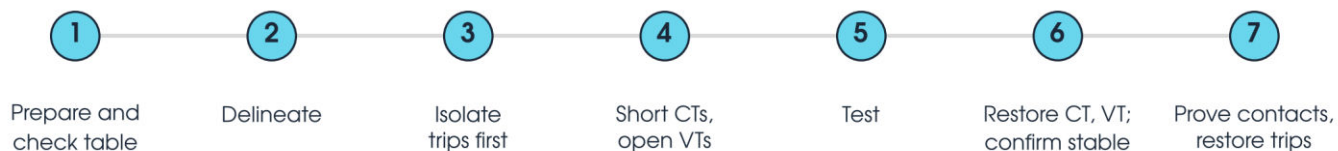
No-go zones marked, isolation points marked on the field side, the isolation table at the panel and checked before use.

Important

This guide sets out principles for competent protection testing personnel. It is not a work procedure and does not replace one. The network operator's or site's access and safety rules, the access permit and a site-specific safe work method statement govern every secondary isolation, and take precedence over anything in this guide.

How Do I Make the Measurement?

Seven Stages



The Checks That Prove It

1 The Table

Checked and signed before use, in the order the isolations are made.

2 The CT Short

Sound and undamaged before it is used.

3 The Order

Breaker fail, trips and intertrips, including software trip signals, are open before any VT or CT link.

4 A Wire With No Link

Not removed unless the site's rules allow it and an upstream isolation point is opened first. Never a CT wire.

At Restoration

5 Before a CT Short Comes Off

The relay side of the CT circuit is complete: test leads and plugs out, wires back, links closed, relay in place.

6 Protection Stable

After CT and VT circuits are restored: nothing picked up, no trip output, no new alarm, and correct measured values where the plant is in service.

7 Before a Trip Link Closes

The trip contact is proven open. A voltmeter alone can mislead: supervision, a solid state output, a parallel path or a missing supply (see page 9).

Good to Know

Count the CT shorts on and count them back. A short left in a panel is a CT circuit that the relay cannot see.

Common Mistakes

Isolating From Memory

No table, or a table nobody checked.

CT Link Opened Before the Short

A dangerous voltage at the open point.

Trip Restored Before the CTs

The scheme operates on restoration and trips plant.

Test Mode Taken as Isolation

A GOOSE trip reaches the breaker.

More Common Mistakes

Test Block Not Understood

The cover or plug opens, or fails to short, a circuit nobody expected.

Short Removed With the Plug In

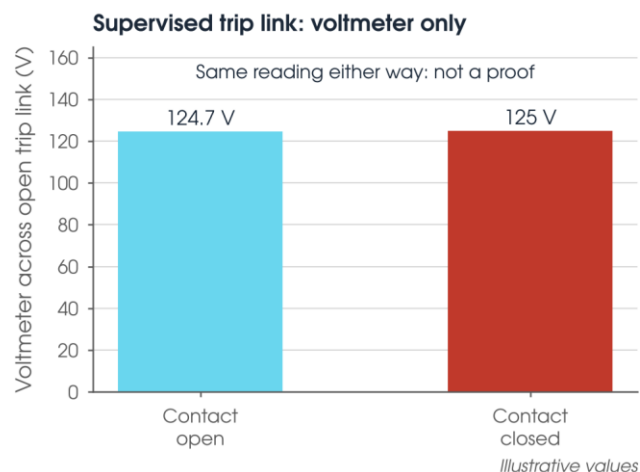
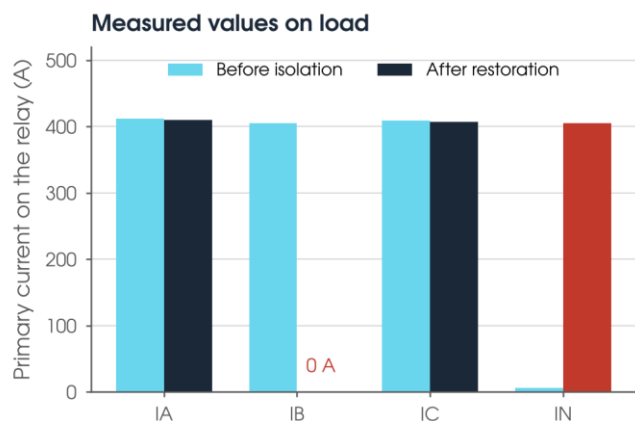
The CT opens through the test plug.

Markers and Existing Isolations Missed

A marker left in, or an existing isolation lost at restoration.

How Do I Read the Result?

Restoration Checks



Phase B reads zero and the neutral carries load after restoration: most likely a CT short left on; if it could be an open CT, treat it as dangerous. Across an open supervised trip link, a voltmeter reads near full voltage whether the contact is open or closed.

Comparing the Result

Against the Record Before Work

Alarms, flags and LEDs match what was recorded before the first isolation.

Against the Load

With plant in service, each phase current and voltage on the relay is consistent with the other phases and the system load.

Against the Table

Every isolation made for the work restored and initialled; every software isolation removed.

Against the Count

Every CT short counted back; every temporary marker removed.

What a Bad Result Looks Like

One Phase Current at Zero

A CT short left on. If an open CT link with no short could be the cause, treat it as an open-circuited CT: dangerous voltage. Keep clear.

Neutral Current on Balanced Load

A phase missing or reversed in the CT circuit.

Voltage Missing on the Relay

A VT link or fuse not restored.

A New Alarm

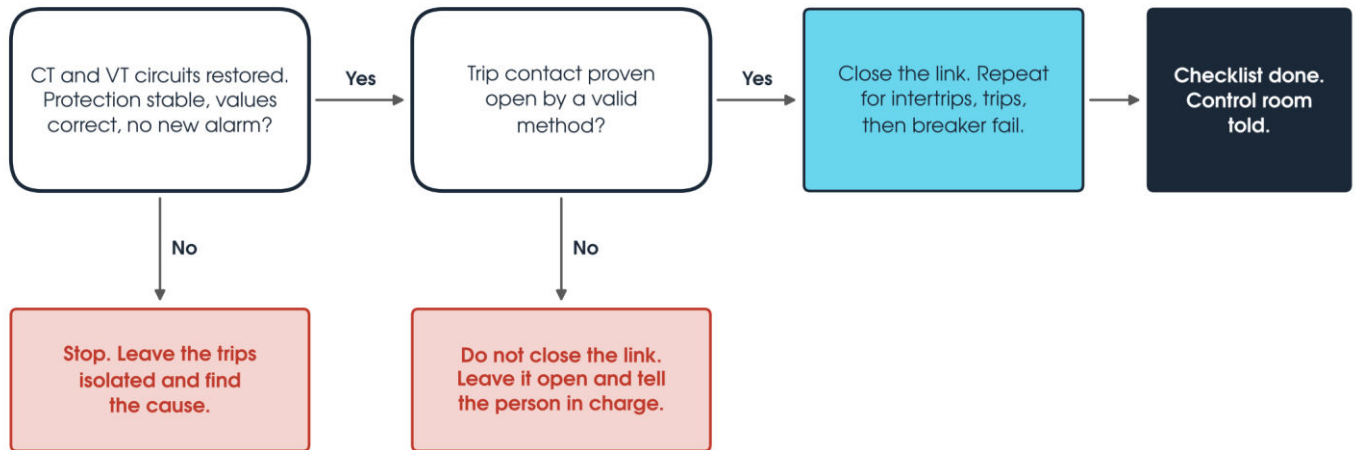
Something not restored, or restored in the wrong order.

Protection Picked Up

Stop: leave the trips isolated and find the cause before going further.

Is My Result OK?

Decision Path at Restoration



Why a Voltmeter Cannot Prove It

In a common trip circuit supervision arrangement, a high resistance sits across the trip contact. Across an open trip link, the meter and the supervision input form a divider:

$$V(\text{meter}) = V_s \times R(\text{meter}) / (R(\text{meter}) + R(\text{supervision}))$$

V_s is the station battery voltage.

Worked Example

A 125 V battery, a supervision input of 25 k Ω and a meter of about 10 M Ω : $V = 125 \times 10,000 / 10,025 = \text{about } 125 \text{ V}$ with the contact open. With the contact closed and the trip coil connected it also reads about 125 V. The meter cannot tell them apart, so a different proving method is needed. Illustrative values.

What to Record

The Table

Every isolation, its point and wire, initialled as it is made and as it is restored.

Existing Conditions

Isolations and alarms found before the work, and confirmed still in place afterwards.

Outages Agreed

Times, the operator's name and any protection outage agreed.

Completion

The restoration checklist, the CT short count, and the control room told the protection is back in service.

What About High Impedance Schemes and Test Blocks?

High Impedance Schemes

A Short Disables the Scheme

A high impedance scheme operates on the voltage that spill current develops across the relay. A CT short connected to the scheme's common wiring gives that current a low impedance path around the relay, so a real fault is not seen.

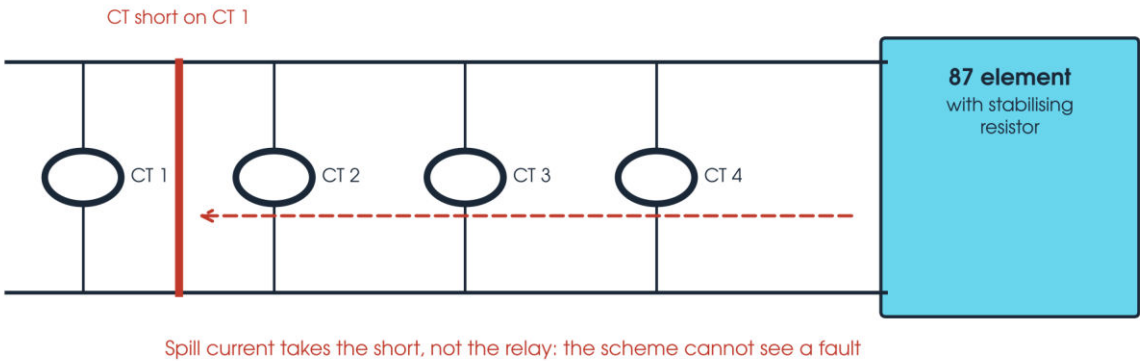
Keep the Outage Short

The scheme is disabled from the moment the short goes on until its link is open, and again on restoration. The operator agrees that outage first.

Primary in Service

Taking one CT out of a scheme whose primary is in service unbalances it, and it can operate on load. Its trips are isolated first.

Why a CT Short Disables a High Impedance Scheme



Test Blocks

Know What It Does

Confirm from the drawings, the block type and the plug type what removing the cover and inserting the plug do to each circuit. If it cannot be confirmed, the cover stays on.

A Complete Path First

Before a test plug goes in, confirm a complete low impedance path through the ammeter (IEEE C57.13.1, A.2.1).

Good to Know

A trip circuit that the plug opens is also opened at its own link, so it stays open when the plug comes out and is restored last.

Recommended Solutions		
Instrument	Capability	Best used for
OMICRON CMC 356	Six current and four voltage outputs	Secondary injection once the scheme is isolated
OMICRON CMC 500 with IEDScout	Multiphase test set with IEDScout	IEC 61850 schemes, including GOOSE isolation checks
OMICRON CPC 100	Primary injection to 800 A	Proving CT circuits through the real wiring, with the primary dead
Megger SVERKER 760	Single phase, up to 100 A or 250 V	Single element relay tests

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

Frequently Asked Questions

Common Questions

What is the purpose of a CT shorting block?

It lets a CT secondary be shorted on the CT side before the relay side is opened, so the CT is never open circuited while current flows.

How does shorting block work?

Shorting screws or links join the CT terminals together on the CT side; the links to the relay are then opened. The order is short first, open second.

How do I short out a CT?

Only under the site's rules and a checked isolation table. The principle: the CT circuit is given a sound short on the CT side before anything opens the circuit to the relay, and the short comes off only after that circuit is whole again.

What are the steps of an isolation procedure?

In principle: a checked table, delineation, trips first, CTs shorted and VTs opened, the work, CT and VT circuits restored and proven stable, trip contacts proven open, trips restored last.

Standards and References

IEEE Std C57.13-2016, Standard Requirements for Instrument Transformers, cl 6.7.1.

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

AS 2067:2016, Substations and high voltage installations exceeding 1 kV a.c., cl 2.1.1.

Simard, H. (Rio Tinto) and Pong, L. (Doble), Current Transformer Doble Testing Tripping Upstring Breaker, 91st International Conference of Doble Clients, 2024.

Megavar, secondary isolation and delineation practice, 2026.

More Questions

Why is a CT shorted before it is opened?

The CT keeps driving its current. With nowhere to go, it develops a dangerous voltage at the open point (IEEE C57.13-2016, cl 6.7.1).

Why must a VT secondary never be shorted?

A VT is a voltage source: a short draws a high current, blows its fuses or damages it, and removes voltage from every device it supplies.

Who should make secondary isolations?

Competent protection testing personnel (AS 2067, cl 2.1.1), authorised under the network operator's or site's access rules.

Does Megavar test protection schemes?

Yes, including IEC 61850 GOOSE schemes. Call 1300 730 499.

Hire or Have It Tested

Have It Tested

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

Next Step

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