

APPLICATION NOTE

Monitoring Multiple Loads Through a Single CT

Routing several conductors through one CT window to meter their combined current

DANGER: HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Follow safe electrical work practices. See NFPA 70E in the USA, or applicable local codes.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Turn off all power supplying the equipment before working on or inside it, and verify with a properly rated voltage-sensing device.
- Install CTs on insulated conductors only.
- **Failure to follow these instructions will result in death or serious injury.**

Overview

A current transformer measures the **net current** flowing through its window. When several conductors pass through the same CT, the CT and the PowerScout channel it feeds report the combined current of all of them. This lets one CT and one meter input monitor a group of loads, for example several lighting or receptacle branch circuits on the same phase, or the parallel conductor sets of a single feeder phase.

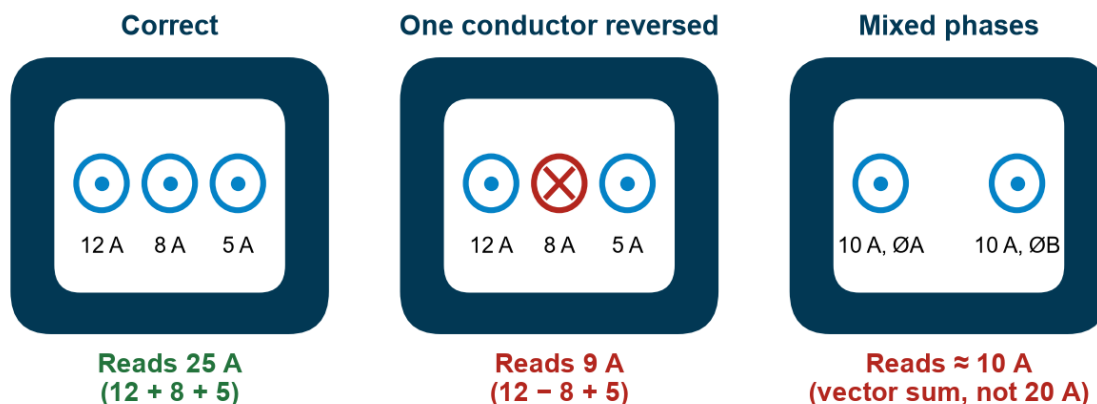
Unlike paralleling CTs, this method needs **no change** to the PowerScout scaling. The CT is simply measuring more current. It applies to both 333 mV split-core CTs and RōCoil (Rogowski) sensors.

REQUIREMENT: SAME PHASE ONLY

- Every conductor through one CT **must be on the same phase**. Never combine phase A with phase B or C on one input.
- Mixed phases add as vectors, not arithmetically. Both the current and the kW reading will be wrong, and nothing on the meter will flag it.
- For three-phase loads, combine per phase: phase A with phase A, phase B with phase B, phase C with phase C.

How It Works

A CT responds to the magnetic field created by all current passing through its window. Currents flowing in the same direction reinforce each other and currents flowing in opposite directions cancel. For conductors on the same phase, all carrying current toward their loads, the CT sees the simple arithmetic sum.



Dot = current flowing with the CT arrow (toward the load). X = current flowing against the arrow.

Figure 1. Three conductors through one CT window: correct, one conductor reversed, and mixed phases.

In the correct case, the 12 A, 8 A, and 5 A conductors produce a reading of 25 A. If the 8 A conductor passes through in the opposite direction, it subtracts, and the CT reads 9 A. If the conductors are on different phases, their currents are 120° apart and add as vectors, so two 10 A loads on phases A and B read about 10 A, not 20 A.

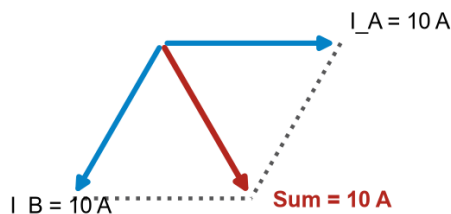


Figure 2. Two equal currents 120° apart sum to the same magnitude, not double.

Requirements

- **Same phase.** Every conductor through the CT must be on the same phase. Mixing phases produces a vector sum and the reading will be wrong. The PowerScout also calculates power using the voltage of the phase that input is assigned to, so conductors on a different phase will give incorrect kW even if the current happened to look right.
- **Same direction.** Every conductor must carry current in the same direction through the window, from source to load, matching the CT arrow. Route all conductors through from the same side of the CT.
- **Line conductors only.** Never pass a circuit's neutral or return conductor through the same CT as its line conductor. The two currents are equal and opposite and cancel to zero.
- **Split-phase (240 V) loads.** Route the L1 conductors through the L1 CT and the L2 conductors through the L2 CT. Do not put both legs of the same load through one CT.
- **Combined rating.** Size the CT for the combined maximum load of all conductors through it, not for any single conductor.

- **Window fit.** All conductors, including their insulation, must fit inside the CT window. On a split-core CT the core must close completely, with clean, fully seated mating surfaces. A core that does not close fully will read low. When sizing, account for parallel conductor runs, which are common on services of 600 A and above.
- **Same side of any transformer.** All conductors must be on the same side of any transformer or other device that changes current magnitude or phase.

Conductor Position and Nearby Conductors

A CT is designed to measure only the current inside its window, but two installation details affect how well it rejects everything else. Both matter more when the window is full of conductors.

- **Position inside the window.** Accuracy is best with the conductors bundled near the center of the window. When the window is full, keep the bundle tight and avoid forcing conductors hard against the split-core joints, which are the least uniform part of the core.
- **Conductors outside the window.** Strong magnetic fields from nearby conductors that are not in the window, especially other phases of the same feeder, can couple into the CT. Where possible, keep other-phase conductors away from the CT body and its joints, and don't install the CT where other-phase bus or conductors press directly against it.
- **RōCoil sensors.** Rogowski coils are more position-sensitive than solid-core CTs, especially at the clasp where the loop closes. Keep the enclosed conductors roughly centered in the loop, position the clasp away from the conductors inside the loop, and keep the clasp away from other-phase conductors outside the loop.

Configuring the PowerScout

Configure the CT exactly as you would for a single conductor:

1. Select the CT model (or RōCoil) from the CT library.
2. Use the library's **Amps** value for that model **unchanged**. The CT's output still represents the current passing through it. It is just measuring more current.
3. Leave **Phase Shift** at the library value.
4. Confirm the channel is assigned to the voltage phase of the conductors.

CT Model	Type	Amps	Phase Shift
	milliVolt	100.23	0.3
	milliVolt	200.5	0.3
	milliVolt	401	0.1
	milliVolt	602.9	0.12
	milliVolt	805.5	0.11
	milliVolt	1208.5	0.05

Figure 3. Example CT library entries (partial). Use the values listed for the model actually installed, as-is.

Accuracy Considerations

Routing several conductors through one CT adds **no error of its own**. The reading is as accurate as that CT and meter are at the combined current, provided the conductors are positioned as described above.

The trade-off is the same as with any CT sized for a larger load. The CT is sized for the combined current, so the reading at light total load sits low in the CT's range, where error is a larger share of the reading. An individual 5 A branch that would be 5% of full scale on its own 100 A CT might be only 1.25% of full scale on a 400 A CT sized for the group. If the group total is normally healthy, this rarely matters. If an individual load needs precise light-load data, meter it on its own input.

Compared with paralleling identical CTs to reach the same total, a single CT is equal or slightly better. There is one CT's tolerance instead of several, and no CT-to-CT mismatch.

Related Technique: Multiple Passes of One Conductor

The reverse also works. Wrapping a single conductor through the same CT window multiple times multiplies the current the CT sees by the number of passes. This improves resolution on a small load measured with a CT that is larger than the load requires.

- Every pass must go through the window in the same direction. Loop the conductor back around the **outside** of the CT between passes.
- Divide the library Amps value by the number of passes. For example, three passes through a CT listed at 100.23 A: $100.23 / 3 = \mathbf{33.41\ A}$. Leave Phase Shift unchanged.
- Confirm that the load current multiplied by the number of passes stays within the CT's rating.

Choosing Between Methods

Table 1. Multiple conductors through one CT vs. paralleled CTs

	Multiple conductors, one CT	Paralleled identical 333 mV CTs
Hardware	One CT or RōCoil per phase	One CT per conductor, per phase
PowerScout Amps setting	Library Amps value, unchanged	Library Amps value × number of CTs
Phase Shift	Unchanged	Unchanged
Best when	Conductors are close together and fit through one window or loop	Conductors are too large, too many, or too far apart for one window
Accuracy	That CT's accuracy at the combined current	Equivalent to one CT of the combined rating, plus a small CT-to-CT mismatch effect
RōCoil sensors	Yes	Not covered
Common to both	Same phase, same direction, same side of any transformer	Same phase, same direction, same side of any transformer

Installation Checklist

- ☐ All conductors through the CT are on the **same phase**.
- ☐ All conductors pass through in the same direction, with the CT arrow pointing toward the load.
- ☐ No neutral or return conductor of the same circuit is in the window.
- ☐ CT is rated for the combined maximum load.
- ☐ All conductors fit, are bundled near the center, and the split core (or RōCoil clasp) closes completely.
- ☐ Other-phase conductors kept away from the CT body, joints, and RōCoil clasp.
- ☐ Amps and Phase Shift left at the library values (or Amps divided by the number of passes for multi-pass).
- ☐ Reading verified against a clamp-on meter reading of the combined load.