

APPLICATION NOTE

Paralleling 333 mV CTs

Monitoring the aggregate load of multiple conductors on a single PowerScout input

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

Identical 333 mV current transformers (CTs) can be wired in parallel to a single PowerScout CT input. The meter then reports the **combined** current of every conductor the paralleled CTs are installed on. This is useful when several feeders, taps, or branch circuits on the same phase need to be metered as one load, or when parallel conductor runs are too large or too far apart to fit through a single CT window.

The key idea: the paralleled output represents the **total current as a percentage of the total CT capacity**. Set the PowerScout input to that combined capacity and a single channel reports the true aggregate load.

REQUIREMENT: SAME PHASE ONLY

- All CTs paralleled onto one input **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

The output represents total current as a share of total capacity

Consider two identical 50 A CTs, each 333 mV at 50 A:

- **CT #1** measures 5 A, which is 10% of its 50 A range. Its output is 33.3 mV, or 10% of full scale.
- **CT #2** measures 10 A, which is 20% of its 50 A range. Its output is 66.6 mV, or 20% of full scale.

- Paralleled, the pair is carrying **15 A** out of a combined **100 A** of CT capacity. The output is **15% of full scale: 50 mV**.

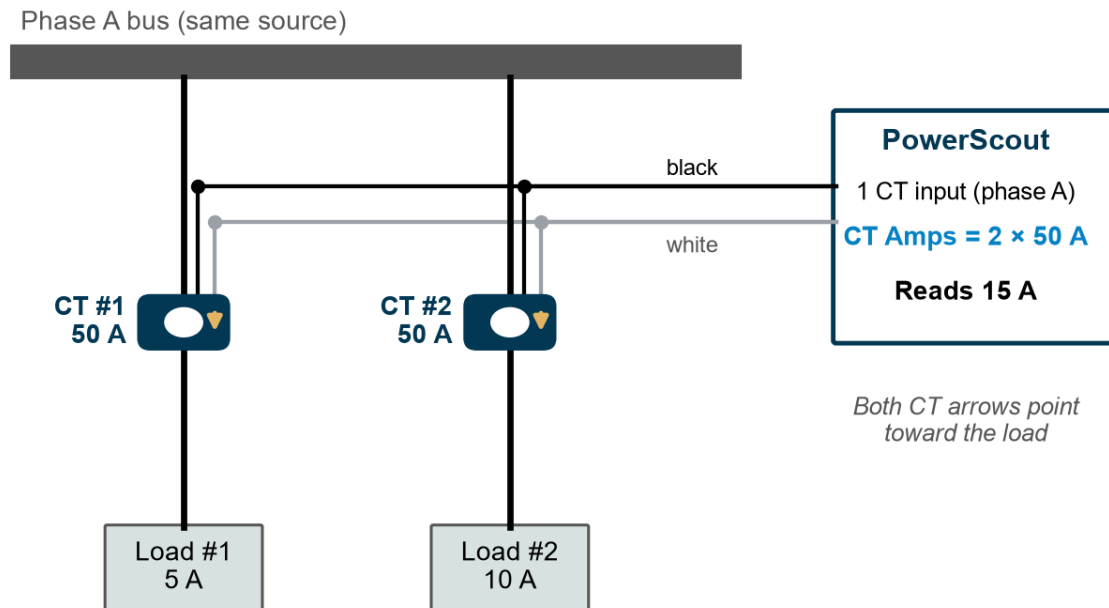


Figure 1. Two identical 50 A CTs on the same phase, paralleled to one PowerScout input.

The input is scaled to the combined capacity

The PowerScout input is configured for the combined capacity of the two CTs: $2 \times 50 \text{ A} = 100 \text{ A}$. A 15% signal on a 100 A input represents **15 A**, which is exactly the 5 A + 10 A being measured.

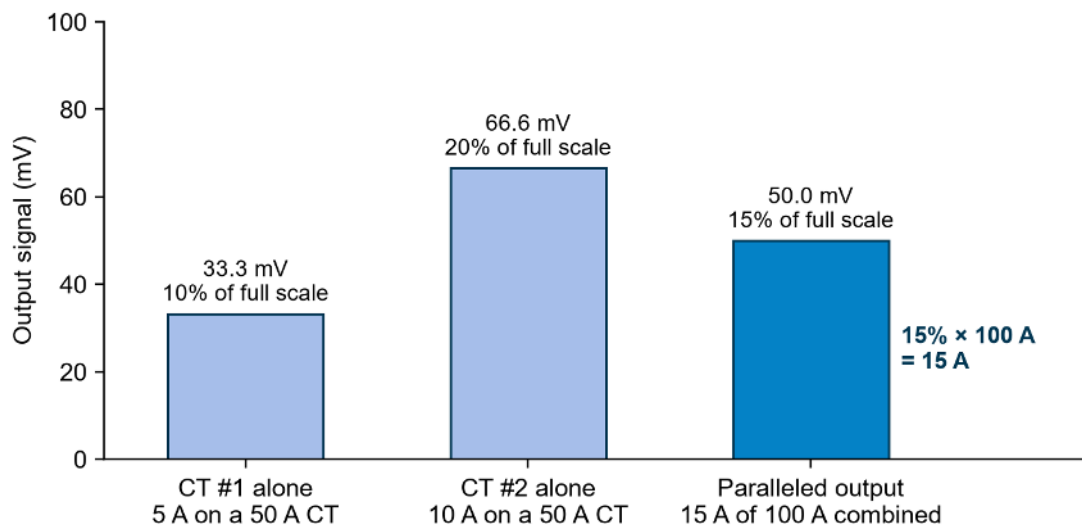


Figure 2. Each CT's signal on its own, and the paralleled output seen by the PowerScout.

In general, for N identical CTs of rating I_{CT} :

$$\text{Output (\% of full scale)} = \text{Total current} / (N \times I_{CT})$$

Because the PowerScout input is set to $N \times I_{CT}$, the reported current is the total current, no matter how the load is split between the CTs.

KEY CONCEPT

- The paralleled output represents **total current as a percentage of total CT capacity**.
- The PowerScout input scaling is **multiplied** by the number of CTs to match that capacity.
- Together, a single channel reports the **aggregate** load of all paralleled CTs, **all on the same phase**.

Why it works

Inside every 333 mV CT, the secondary winding drives a current through an internal burden resistor, and the voltage across that resistor is the CT's output. When identical CTs are paralleled, two things happen. Their secondary currents **add**. And their burden resistors are now **in parallel**, so the combined burden is 1/N of a single CT's. The total current flowing through the reduced burden produces an output that is the total current as a share of the combined capacity.

The CT currents add ($i_1 + i_2$) and flow through both burden resistors in parallel ($R/2$)

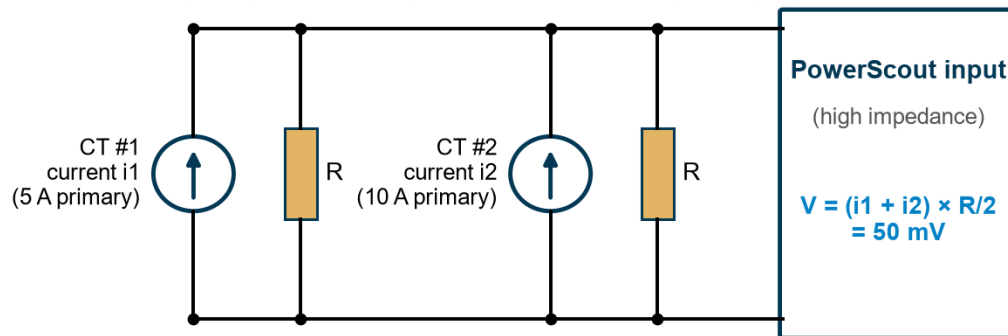


Figure 3. Simplified circuit: the CT currents add and flow through the paralleled burden resistors.

This is also why the CTs must be identical. The combined current divides among the burden resistors, so if one CT's burden resistance differs from the others, that CT has more or less influence on the output than it should, and the reading drifts whenever the loads are unequal. If the current ratings differ (for example, a 50 A CT paralleled with a 100 A CT), 333 mV means a different current for each CT and no single scaling value can make the reading correct.

Configuring the PowerScout

1. Select the CT model used for every paralleled CT from the CT library, as normal.
2. Take that model's **Amps** value exactly as it appears in the library (the calibrated value, not the nominal rating) and **multiply it by the number of paralleled CTs**. Enter the result in the Amps field.
3. **Leave Phase Shift unchanged.** Phase shift is a characteristic of the CT model. Every paralleled CT shares it, so the combined output carries the same phase shift as a single CT.
4. Confirm the channel is assigned to the voltage phase the CTs are installed on.

For highest accuracy, always start from the library's calibrated Amps value for the exact model installed. The CT library covers many CT models and ratings, and each has its own calibrated Amps and Phase Shift values. Figure 4 shows a few example entries. In that example, a CT listed at **100.23 A** paralleled with a second identical CT would be entered as **$2 \times 100.23 = 200.46 \text{ A}$** , with Phase Shift left at **0.3**.

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 4. Example CT library entries (partial). Use the values listed for the model actually installed.

Confirm the multiplied value is within the Amps range the PowerScout configuration accepts.

Installation Requirements

- **Identical CTs.** Every paralleled CT must be the same model and the same current rating.
- **Same phase.** All paralleled CTs on an input must be on the same phase. The PowerScout calculates power from that input's current and the voltage of its assigned phase. Currents on different phases add as vectors, not arithmetically, producing an incorrect current and power reading. Ideally the CTs monitor taps from the same bus.
- **Same side of any transformer.** Do not parallel CTs installed on opposite sides of a transformer or any other device that changes current magnitude or phase.
- **Consistent orientation.** Install every CT with its arrow pointing toward the load. A reversed CT subtracts its current from the total instead of adding it.
- **Stay within each CT's rating.** The channel is scaled to the combined capacity, but each individual CT must still stay within its own rating. For example, with two 50 A CTs set to 100 A, a 70 A load on one CT and 0 A on the other would over-range that CT, even though the combined total is under 100 A.
- **Consistent leads.** Join the black leads together and the white leads together. Use connectors rated for the application, and keep lead lengths and wire gauge reasonably similar across the paralleled CTs.
- **Three-phase loads.** Parallel per phase: all phase A CTs to the phase A input, all phase B CTs to the phase B input, and so on.
- **333 mV CTs only.** This method applies to 333 mV output CTs. For RōCoil (Rogowski) sensors, see the section below.

Accuracy Considerations

Compared with one CT of the combined rating: essentially the same

A paralleled input behaves like a single CT rated at the combined capacity. Two 100 A CTs on a 200 A input produce the same signal for a given total current as one 200 A CT would. Resolution relative to the combined range is not reduced.

Each CT's tolerance carries through to the total, but it does not compound: if every CT is within its accuracy specification, the combined reading is within that same percentage of the total. The one added error source is CT-to-CT variation in burden resistance, which gives the CT with the lower resistance slightly more influence on the combined output. It only matters when the loads on the CTs are very unequal, and is small for CTs of the same model. Where it is a concern, measure the resistance across each CT's leads before installation and parallel the closest-matched CTs.

Compared with metering each load separately: lower resolution at light load

The trade-off is that every load is measured on the combined scale. A 5 A load on its own 100 A CT is 5% of full scale. The same 5 A on a channel of four paralleled 100 A CTs (400 A) is 1.25% of full scale, where CT and meter error is a larger share of the reading. This is the same trade-off as using any oversized CT.

- Size the CTs so the **combined** load normally sits well up in the combined range, not near the bottom of it.
- Keep the number of paralleled CTs practical. The combined range grows with every CT added.
- If light-load accuracy on an individual load matters, meter that load on its own input.

RõCoil (Rogowski) Sensors

DENT RõCoil sensors are not 333 mV CTs. They are passive Rogowski coils with a di/dt output of 131 mV per 1000 A at 60 Hz, and the PowerScout integrates the signal internally. The burden-resistor behavior and Amps $\times$ N scaling described in this note are specific to 333 mV CTs, and **paralleling RõCoil sensors is not covered by this note.**

RõCoils are usually the better answer anyway. Their flexible loops (window sizes up to 14.6 in.) can enclose several conductors of the same phase, including large parallel feeder runs. See the companion application note, **Monitoring Multiple Loads Through a Single CT.**

Installation Checklist

- ☐ All CTs are the same model and current rating.
- ☐ All CTs are on the **same phase**, on the same side of any transformer.
- ☐ All CT arrows point toward the load.
- ☐ Black leads joined to black, white leads joined to white, landed on one input.
- ☐ Amps = library Amps value for the installed model $\times$ number of CTs.
- ☐ Phase Shift left at the library value for that CT model.
- ☐ No single CT will carry more than its own rated current.
- ☐ Reading verified against a clamp-on meter reading of the combined load.