Application Notes for the Integration of Current Transformers with mA Secondary

The integration of a current transformer into an application intended for the monitoring and/ or measurement of electric power should be approached with an understanding of the impact of the electronic design on the performance of the current transformer. Designing the appropriate interface will assure the best performance for:

- Signal transformation accuracy,
- Linearity over the rated operating range and
- Minimal phase shift between the primary and secondary.

Current transformers are available in three physical configurations;

- Clamp-on current transformer,
- Split-core current transformer, and
- Solid core current transformer
  - Single loop primary through the center of the CT,
  - Multiple loops, pre-wound primary to secondary ratio CT.

The secondary output of the current transformer may be;

- AC Current signal at the mA level or
- AC Voltage signal at the mV level.

The accuracy of the current transformer is a function of the secondary burden impedance and the operating range.

For current transformers with current secondary outputs in the mA range, the lower the secondary burden impedance, the better the accuracy performance.

For current transformers with voltage secondary outputs in the mV range, the higher the secondary burden impedance, the better the accuracy performance. Typical burden impedance should be in the > 100k ohm range.

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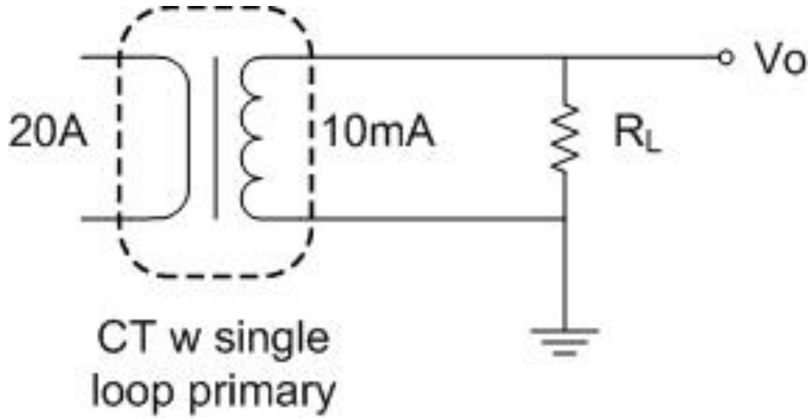
Burden Resistor Interface:



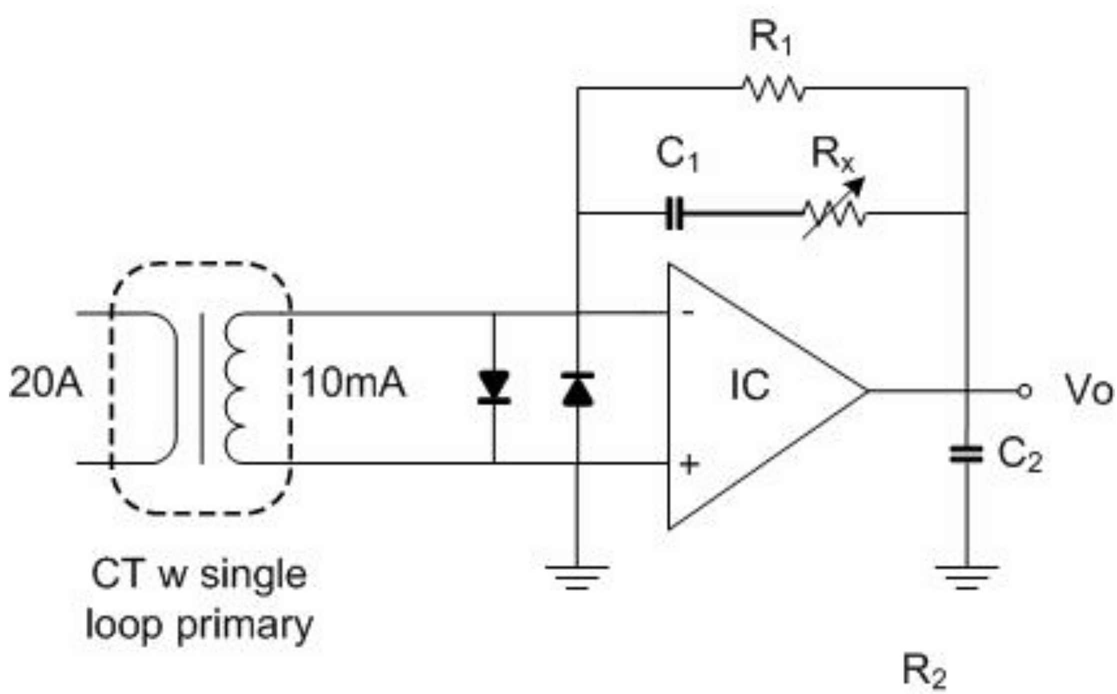
Advantage:

- Simple sampling circuit

Disadvantage:

- Large burden resistance will result in larger transformation error and larger primary to secondary phase shift.
- Linearity range will decrease with the possibility of saturation at relatively low primary current levels.

Op Amp Interface:



Advantage:

- Minimal burden on the secondary of the current transformer, improving transformation accuracy and minimizing primary to secondary phase shift.

Disadvantage:

- Additional components required for CT interface.

Notes:

R_1 (kOhms) **–** Feedback resistor, value selected to provide the required output voltage – **V_0**.

R_x (kOhms) & **C_1** (µF) **–** Compensate for phase shift. The pair may be eliminated if phase shift compensation is not required.

φ - Phase shift with the CT at zero load state in minutes.

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Example CT Configured for Primary: 5A/ Secondary 2.5mA:

Assuming that a value of 5V is the desired $\mathbf{V_0}$ at rated primary current and a phase shift of ≤ 15'.

- IC in this example is an OP07.
- $\mathbf{R_1}$ (Feedback resistor) value can be determined by $\mathbf{V_0}$ / $\mathbf{I_{Secondary}}$ or 5 / 2.5 or 2 kOhms. If greater precision is required, an adjustable resistor may be added in series with a smaller value for $\mathbf{R_1}$.
- The empirical value for $\mathbf{C_1}$ is 0.010 µF to 0.033 µF:
  - If $\mathbf{C_1}$ is 0.033 µF: $\mathbf{R_x}$ = 95 times $\sqrt{\frac{22R1}{\varphi} - 1}$ = 95 times $\sqrt{\frac{22\ times\ 2}{15} - 1}$ = 132 kOhms
  - If $\mathbf{C_1}$ is 0.022 µF: $\mathbf{R_x}$ = 143 times $\sqrt{\frac{15R1}{\varphi} - 1}$ = 143 times $\sqrt{\frac{15\ times\ 2}{15} - 1}$ = 143 kOhms

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