

# TechTopics No. 114

## Low-ratio current transformers in medium-voltage controllers

In medium-voltage motor controller (MVC) design and construction, very frequently there is a need for low-ratio current transformers (CTs) to correspond to low full-load currents of the motors controlled by the starters. At the same time, users want the equipment to be as compact as possible while achieving the necessary CT relay accuracy class. To accomplish both objectives, multiple primary turns are used on CTs to allow use of a higher ratio CT (with the desired relay accuracy class) to provide the effective lower ratio needed for the application.

The purpose of this issue of TechTopics is to discuss the application of multiple primary turns on CTs as used in Siemens' controllers.

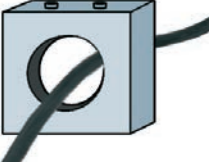
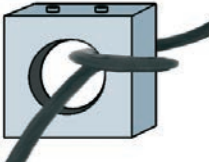
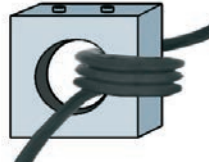
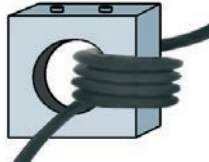
The basic fundamentals of MVC application are:

- In a class E2 controller, the short-circuit protection is provided by current-limiting fuses. Overload relays and their associated CTs are provided only for overload/locked rotor and low-level fault protection and are not required for short-circuit protection.
- Medium-voltage motors often have low full-load currents, with values of 30 A-50 A not uncommon.
- The CTs used in MVC construction are toroidal type to conserve space inside the controller compartment.
- Toroidal CTs do not have a primary conductor, but instead rely on the primary cable that passes through the CT and connects between the load side of the contactor and the outgoing cable terminal pads for motor cables. Thus, the number of primary turns is one, and a low-ratio CT (e.g., 50:5, turns ratio 10:1) has relatively low accuracy for a CT that physically fits inside the controller compartment.

- By wrapping the primary conductor through the CT window several times, the turns ratio can be adjusted, and thereby allow use of a toroidal CT while obtaining acceptable accuracy.
- An alternative is available, that of using wound-type CTs, wherein the CT does have a primary conductor, and the primary conductor is wrapped around the CT core multiple times during manufacture. These CTs accomplish the same basic function of a toroidal CT with multiple primary turns, but require substantially more space in the MVC compartment and are much less economic.

Consider a typical example of use of higher ratio CT to provide the effective low ratio needed. The example CT in the figure is a 200:5 CT but the application needs a different (lower) ratio. This 200:5 CT could be used to provide effective ratios of 40:5, 50:5, or 100:5 by the use of five, four, or two primary turns.

In these examples, a 200:5 CT is used with a relay-accuracy class of C10, which is unchanged as the number of primary turns is changed. In contrast, if a 40:5 CT were available, its relay accuracy would be approximately C2, which would be unacceptable for the application. Thus, it is clear that use of higher ratio CTs and multiple primary turns allows for an economic solution for the user, efficient use of space, and sufficient accuracy for the required application.

CT ratio	200:5	200:5	200:5	200:5
Turns ratio	40:1	40:1	40:1	40:1
Primary turns	1	2	4	5
Effective CT ratio	200:5	100:5	50:5	40:5
Effective turns ratio	40:1	20:1	10:1	8:1
	One primary turn 	Two primary turns 	Four primary turns 	Five primary turns 

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Siemens Industry, Inc.  
7000 Siemens Road  
Wendell, NC 27591

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For more information, contact: +1 (800) 347-6659

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