Paralleling CTs for the B30 to Reduce CT Input Requirements

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INTRODUCTION

The B30 Bus Differential Relay is a low impedance digital busbar relay. Security on internal faults and CT saturation is achieved through restrained differential characteristic, CT saturation detection mechanism, and extra directional operating principle. All three elements of the B30's very secure algorithm require the bus currents to be measured individually. Only in such circumstances the relay actually uses the restraining current, is capable of detecting CT saturation on external faults, and can successfully detect fault direction to prevent false tripping on external faults.

EXAMPLE CONFIGURATION

Consider the system shown in below in which CT-1 and CT-2 are paralleled.

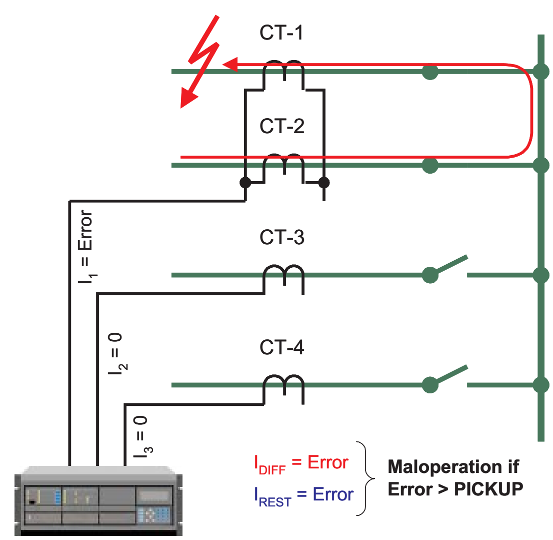

FIGURE 1. **Sample System with Two CTs Paralleled**

Assume for simplicity that all other circuits are disconnected and only circuits No. 1 and 2 are connected to the bus. Shall an external fault on circuit No. 1 occur under this bus configuration, the fault current will flow from circuit No. 2 into circuit No. 1. The current supplied to the relay, however, is a sum of the two currents. Initially, this current equals zero, as both the CT shall perform well. If one of them starts to saturate, however, an error signal will occur. The error current is a net difference between the two secondary currents and may be as high as tens of percent of the fault current. The relay would see the error current as its differential signal. At the same time the restraining signal equals the error signal as well, and the situation is similar to a single infeed internal fault. When the error signal becomes higher than the pickup setting of the differential protection function, the relay will misoperate.

This is not weakness particular to the B30 but a consequence of using virtually unrestrained differential principle; no matter how much current flows through CT-1 and CT-2, the relay will not respond to these currents and will not produce any restraining signal.

Of course, the situation is not that dramatic if other circuits capable of supplying a fault current are connected to the bus. They will produce restraining signal that may be high enough to prevent relay misoperation.

Even under such circumstances, the application is risky. Consider for example, the following secondary currents under external fault on circuit No. 1.

- CT-1: 18 pu $\angle 180°$ (CT-1 is saturated, the actual current is 25 pu)
- CT-2: 20 pu $\angle 0°$ (strong source)
- CT-3: 5 pu, $\angle 0°$ (weak source).

The relay is supplied with two currents:

- CT-1 + CT-2 = 2 pu $\angle 0°$
- CT-3 = 5 pu $\angle 0°$

The differential signal is 2 pu $\angle 0°$ + 5 pu $\angle 0°$ = 7 pu. The restraining signal is max (2 pu, 5 pu) = 5 pu. Both the currents are in phase. The relay would and should trip, as the situation resembles an internal fault. But in this case, that would be a misoperation.

CONCLUSION

External summation of the CTs may be considered under the following conditions:

1. Neither of the two circuits that are paralleled is capable of producing any significant fault current. Ideally they should feed pure loads.
2. Even if the two circuits feed loads, some infeed is possible on ground faults through the zero-sequence current unless the loads are connected in delta. The effect of the zero-sequence infeed current on CT saturation must be considered when calculating settings.
3. The paralleled CTs are guaranteed to operate correctly (with minimal errors) in the situation when there is not extra restraint and the fault current flows in and out of the zone ‘unnoticed’. Or, in other words, the pickup setting is high enough to prevent misoperation due to saturation of the paralleled CTs.
4. If needed, the situation shown in the above figure shall be identified through input contacts, and appropriately settings shall be applied through multiple setting groups in order to ensure security.

Overall, paralleling CTs for low impedance differential applications is always risky and shall be approached with maximum caution.