Application Note AN2019-02

Test Set Configuration for Open-Delta PT Connection

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INTRODUCTION

This application note explains how to inject the proper phase-to-phase voltages to test a relay that is connected to an open-delta PT. SEL recommends grounding the B-phase near the relay location for safety purposes, as shown in Figure 1.

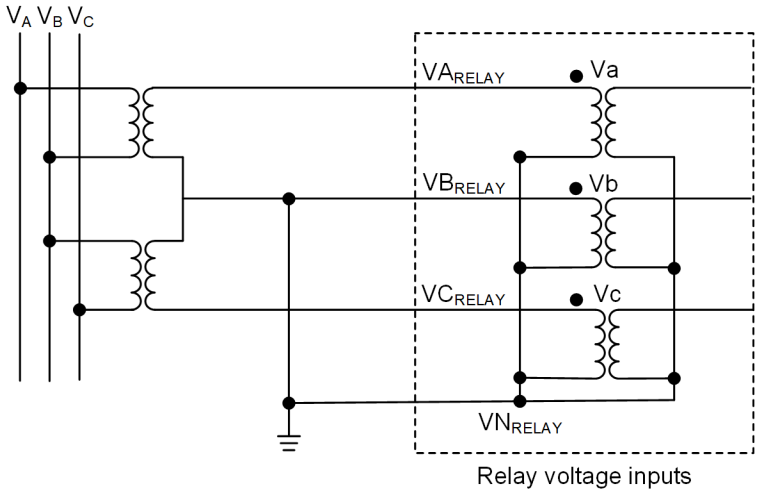

Figure 1 Open-delta PT connection

In an open-delta PT connection, V_A, V_B, and V_C voltages are connected to the VA_{RELAY},VB_{RELAY}, and VC_{RELAY} inputs. VB_{RELAY} is connected to VN_{RELAY} using a jumper, which should be as short as possible and not have an isolation device (such as a potential switch) between VB_{RELAY} and VN_{RELAY}. Since the relay defines VN_{RELAY} to be zero volts (reference), $VB_{RELAY} = VN_{RELAY} =$ 0 volts.

The relay measures VA_{RELAY} to VN_{RELAY} as V_{AB} and VC_{RELAY} to VN_{RELAY} as V_{CB}. From these two voltages, the relay calculates V_{BC} and V_{CA}. Figure 2 shows the system voltages (V_{AB}, V_{BC}, and V_{CA}) and ideal phase-to-ground voltages.

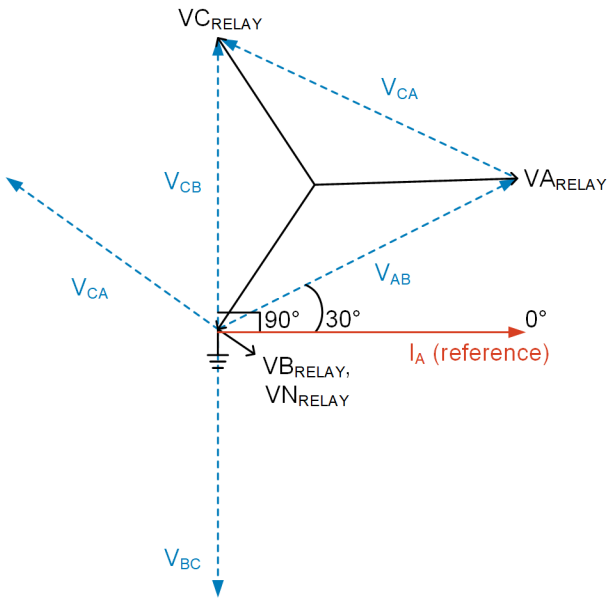

Figure 2 Phase-to-phase voltages in open-delta PT connection with I_A as reference at power factor = 1 (ABC phase rotation)

The relay calculates the actual phase-to-phase voltages, as follows:

- $V_{AB} = VA_{RELAY} - VN_{RELAY}$
- $V_{BC} = -(VC_{RELAY} - VN_{RELAY})$
- $V_{CA} = VC_{RELAY} - VA_{RELAY}$

When completing a metering test, remember that the V_{AB} voltage leads the I_A current by 30 degrees for a power factor = 1 condition (ABC phase rotation).

With respect to the A-phase current (I_A) as reference (0 degrees) as shown in Figure 2, inject the following voltages into the relay, where 120 V is the nominal phase-to-phase secondary voltage:

- $V_A - V_N = 120\angle 30$ (ABC), $120\angle -30$ (ACB)
- $V_B - V_N = 0$ (ABC and ACB)
- $V_C - V_N = 120\angle 90$ (ABC), $120\angle -90$ (ACB)

Using these voltages with a balanced three-phase current (I_A at 0 degrees), the relay displays a power factor = 1 condition.

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