case study

Arizona Public Service

Protection of a 230 kV Line Using Relay with Both Conventional & Optical CT Inputs

Bucket truck used to install 230 kV NXVCT system at Deer Valley Substation in Phoenix, Arizona.

Introduction

Arizona Public Service (APS) has installed a NxtPhase 3-phase 230 kV NXVCT, an L-PRO Line Protection Relay and a TESLA fault recording system at the Deer Valley Substation in Phoenix. This installation tests, among other things, the performance of the NXVCT for protection applications by using the L-PRO's unique ability to accept and operate on both optical and conventional signals. The NXVCT and the L-PRO both performed correctly during a severe fault at the substation.

System Configuration

The L-PRO line protection relay monitors the high voltage line and is connected in a ring bus configuration (see single line diagram below). The L-PRO's low energy inputs are fed by the optical NXVCT, while it also accepts 5A conventional CT signals. The TESLA disturbance fault recorder also monitors both signals. Fault records are triggered by existing protection, new protection, and by breaker opening and closing.

In order to demonstrate the NXVCT's metering performance, its high-energy outputs are connected to a conventional Class 2 (1A input) meter (for clarity not shown in diagram). These readings are compared with existing metering equipment connected to conventional instrument transformers installed next to the NXVCT.

The Deer Valley NXVCT system uses 2 sets of current sensing optical fibers: one for protection (2 turns of fiber in the sensing head), and one for metering (16 turns of optical fiber in the sensing head). At this installation, the 2-turn current sensor signal (200 mVrms nominal) is brought into the L-PRO relay for protection application. The 16-turn signal (4 Vrms nominal) is the input signal for the current amplifier, that produces a 1 Arms nominal signal output. This output is fed into APS's meter. One LEA 4 Vrms signal is being monitored by the TESLA to compare the 1 A amplifier's input and output signals.

The optical CT, conventional CT, and VT each feed signals to the L-PRO line protection relay. Not only does this configuration allow APS to compare optical and conventional current signals, it also demonstrates the use of a relay using mixed input signals.

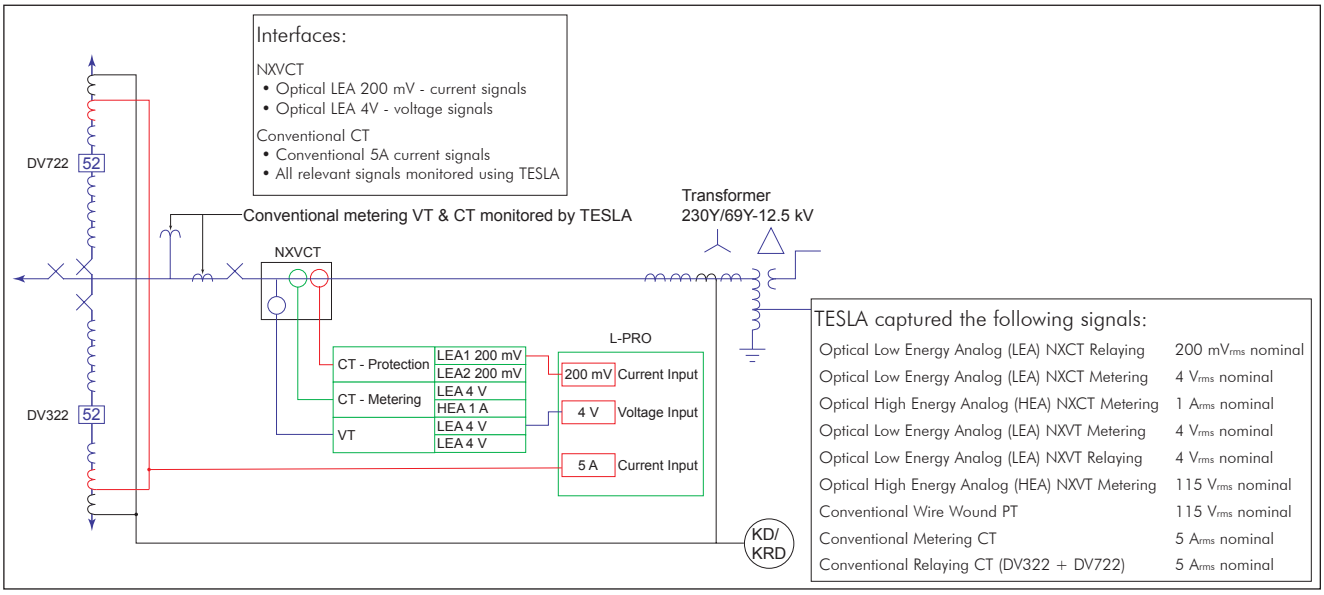


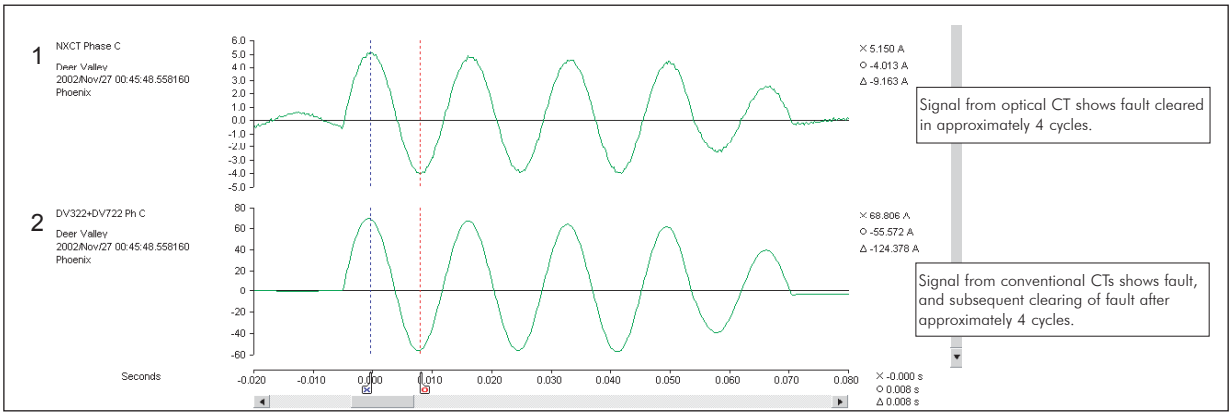
Figure 1: Sketch of single line.

NXTPHASE
Tel: 604-215-9822
Fax: 604-215-9833
www.nxtphase.com
info@nxtphase.com

Successful Clearing of a Fault Using Mixed Input Relay

On November 27, 2002, APS experienced a bus fault at the Deer Valley Substation, with an approximate magnitude of 29,520 A_{peak}. Data captured by the NxtPhase TESLA recorder was analyzed and showed that both the L-PRO relay and NXVCT sensor behaved properly.

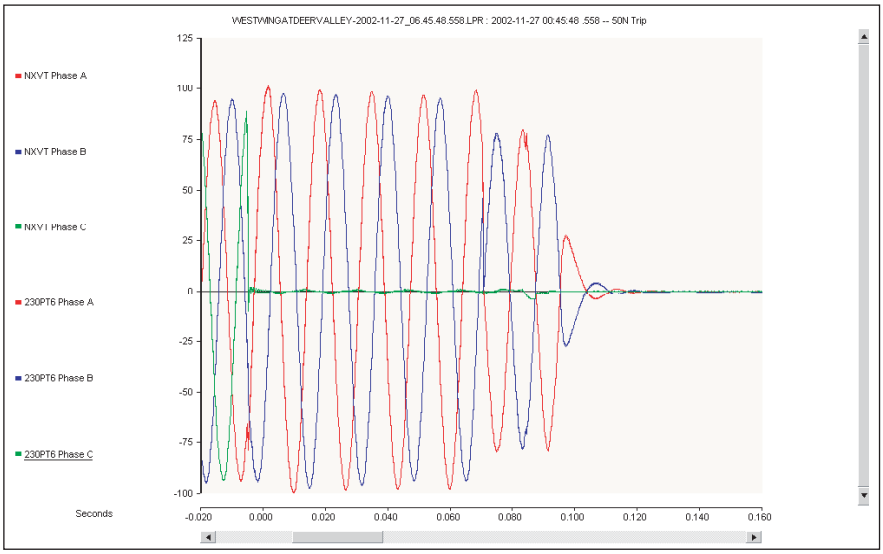
The waveforms captured by the L-PRO during the fault (see illustration below) show the correct performance of the optical current sensor in replicating the fault current. These waveforms also illustrate the L-PRO's ability to operate successfully with different inputs (both high and low energy analog signals).



1 NXCT phase C phase protection LEA signal, 200 mV_{rms}.
2 Summation of C phase current signals from CTs on breakers DV322 and DV722.

Voltage Signals

There is no noticeable difference between the optical and conventional voltage output signals.



A, B, and C phases of the NXVCT optical voltage signal may be compared with 230PT6 A, B, and C phases of the conventional wound PT transformer.

Conclusion

APS's innovative configuration of both optical and conventional instrument transformers will allow them to properly evaluate the NXVCT's performance for protection and metering applications. The system has performed as expected, illustrated most conclusively during a bus fault.