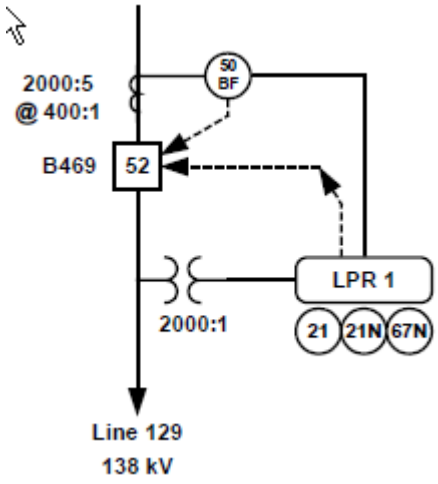
Capturing Residual Current in TESLA Records

The zero sequence current flowing in the power system is used as a quantity for ground protection on transmission lines and distribution feeders. For most applications, the zero sequence current is determined from the residual current flowing through the star point of wye-connected CTs. This is simply an electrical summation of the phase quantities, resulting in the zero sequence current. Disturbance Fault Recorders (DFRs), like the TESLA Disturbance Recorder from ERLPhase, need to include the residual or zero sequence current in waveform captures for transient fault events. The TESLA, like most DFRs, can directly capture residual current by connecting the star point to an analog input channel. However, the TESLA provides a simpler, and less expensive, method to record the current. The TESLA provides summation channels that can mathematically calculate the zero sequence current from the three individually measured phase currents. The use of a summation channel simplifies the physical design of a recorder installation, and eliminates the time and expense of wiring an additional channel to measure current. This application note describes how to configure a summation channel to capture the zero sequence current in a TESLA recorder.

Application

A typical application to record the zero sequence current is for a transmission line. This application note uses Line 129, a 138 kV line with a single breaker line terminal, as an example. The protection on Line 129 includes ground distance and ground overcurrent functions, that both use zero sequence current as an operating quantity.



Summation Channels

Summation channels in the TESLA are virtual channels that mathematically add together the signals from 2 or 3 analog input channels to create an additional analog quantity. Triggering for a summation channel is identical to triggering for any other analog channel. Triggers can be set for high or low magnitudes, and positive or negative rate-of-change. Summation channel triggers can be used to start fault records, power swing records, cross-trigger other recorders, or control output contacts.[1]

Calculating Residual Current

Setting up the TESLA to capture zero sequence current is a simple, three step process:
- Create an Element for the transmission line
- Configure an analog input channel for each of the three phase currents
- Create a Summation channel to calculate the zero sequence current.

All of these steps are performed in the TESLA Control Panel configuration software. The first 2 steps are thoroughly described in the TESLA instruction manual, so they are not detailed here.[2] The step to create a new Summation depends on the view mode of the Configuration editor, which is either the Element view or the Channel Tree view.[3]

In Element view:
- Select the Line 129 element
- Select Config->New Summation…->New IN from the pull down menu

[1] TESLA Manual provides a more detailed description of Summation channels.
[2] TESLA Manual describes creating an Element, and creating an Analog Input Channel.
[3] TESLA Manual describes the Element view and the Channel Tree view.

In Channel Tree view:
- Select an available Summation
- Select “Line 129” in the Element dropdown box
- Select “InSum” in the Type dropdown box

To complete the Summation, simply set Input 1 to the Line 129 A phase current, Input 2 to the Line 129 B phase current, and Input 3 to the Line 129 C phase current. The Scale Factor for each of these inputs should be the default setting of 1, and the Angle Offset should be the default setting of 0. The TESLA will now calculate the zero sequence current for the Line 129 element.[4]

TESLA Summation Function Configuration

Element	Type	Description	Summation Index
Line 129	InSum		16

Units: **A**
Scale: **400 A/A**
Rate of Change Interval: 1.0 Cycle(s)

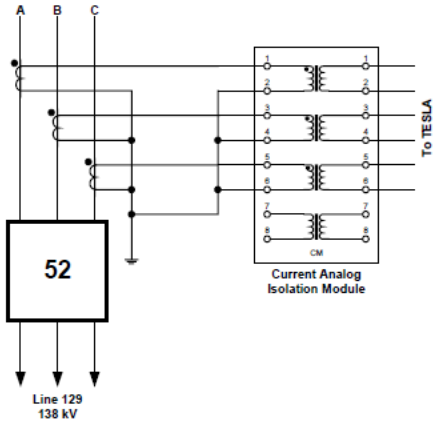
Define Inputs:

	Element:Type: Description		Scale Factor		Angle Offset
Input 1	Line 129:Ia	X	1	∠	0
Input 2	Line 129:Ib	X	1	∠	0
Input 3	Line 129:Ic	X	1	∠	0

	Limit		Delay		Enable	Fault	Swing	Log	Notify	Cross Trigger	Priority	Alarm Contact
High Magnitude	1	A	0	sec	☑	☑	☐	☑	☑	☐	1	--
Low Magnitude	0	A	0	sec	☐	☐	☐	☐	☐	☐	1	--
Negative Rate of Change	0	A	0	sec	☐	☐	☐	☐	☐	☐	1	--
Positive Rate of Change	0	A	0	sec	☐	☐	☐	☐	☐	☐	1	--

Triggering on Residual Current

Once the summation is set up, triggers are set in the same manner as any other analog trigger. For zero sequence current, a recorder usually triggers for an overcurrent condition. This example triggers on an overcurrent event through the High Magnitude setting of 1 $A_{secondary}$. The High Magnitude event triggers a fault recording, stores the occurrence in the sequence of events log, and provides automatic notification to the RecordBase Central Station master software.



Conclusions

Summation channels allow the TESLA Disturbance Recorder to create virtual analog channels. This allows the TESLA to trigger recordings for events based on values that don’t have to be directly measured. This application note describes the most common of these applications; the use of a summation channel to derive the residual current in wye-connected CTs. This application frees up an analog input channel to directly record another quantity. This application also eliminates the need to wire the residual current directly to the TESLA, as shown in the simple wiring schematic.

[4] TESLA Manual describes setting up a Summation in detail.