

Application Note

BE1-FLEX Continual Analog Testing

Testing protective relays, or any equipment in a power system, has been long considered critical to ensure the equipment is in working condition and reliable.

Protective relays have dramatically increased reliability and self-diagnostic functionality over the years. This has led to a decrease in frequency between testing. The problem with nearly all digital protective relays is that they can only test their digital components. There is nothing previously available to test accuracy. Anything analog requires a second measurement source to validate accuracy.

The testing interval itself is an interesting scenario to consider. If testing is performed every 4 years and a relay is found failed, the user has no real knowledge or awareness of when the device failed. It could have been faulty and in service for 1,460 days (do not forget to add the leap year). To think of it another way, every device that fails test was believed to be healthy up until it was tested, and over this window, it has a potential to false operate. Therefore, one of the core fundamentals of relay testing has a significant imperfection.

There is also the possible introduction of failure during testing. Regardless of how regimented a test technician is in their work, it is still possible that the procedure, automated routing, or process has a flaw and the

system is not put back together exactly as it was before the test process. This could be a buried setting in a relay that was supposed to be only temporarily disabled or something as simple as leaving a CT shorting pin in place. This has led some users to abandon periodic testing all together while the relay is core of its expected lifespan.

It is easy to see that a system without testing could have problems and device issues can be introduced while testing. There is also substantial cost associated with periodic maintenance. With the BE1-FLEX, you do not need to make this decision. You can have regular testing without the cost and possible error introduction of periodic testing. The method described next will validate the analog measurements of the BE1-FLEX against a second analog measurement over 200 times per second, continuously.

To perform this task, a single BE1-FLEX can be configured with two boards that are monitoring the same current and voltage transformers. In addition, because the analog to digital conversion is performed on each board independently, the accuracy of each board's analog circuitry is independent of the other.

An internal block diagram with the board and analog-to-digital conversion location is shown in Figure 1.

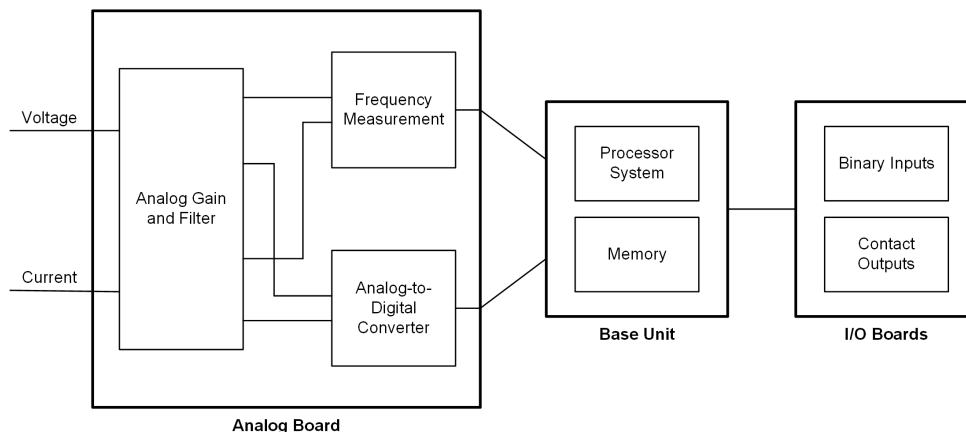


Figure 1 - Top Level Typical Protective Relay Function Block Diagram

BEI-FLEX configuration using BESTCOMSPlus® is shown in Figures 2 through 5.

As an example, Figures 2 and 3 show a style configured to have two identical analog boards.

Figure 4 shows one analog board mapped to Circuit 1 (Primary). This will be used for protection as usual.

Figure 5 shows second analog board mapped to Circuit 2 (Backup Circuit). This will be used to compare to Primary to verify analog boards are working correctly.

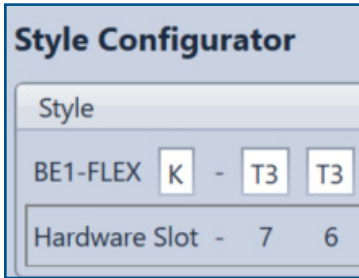


Figure 2 - Style Configurator

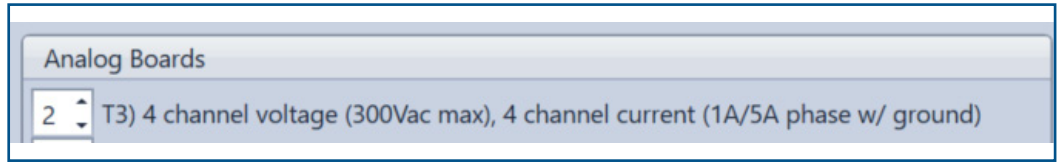


Figure 3 - Analog Boards Configuration

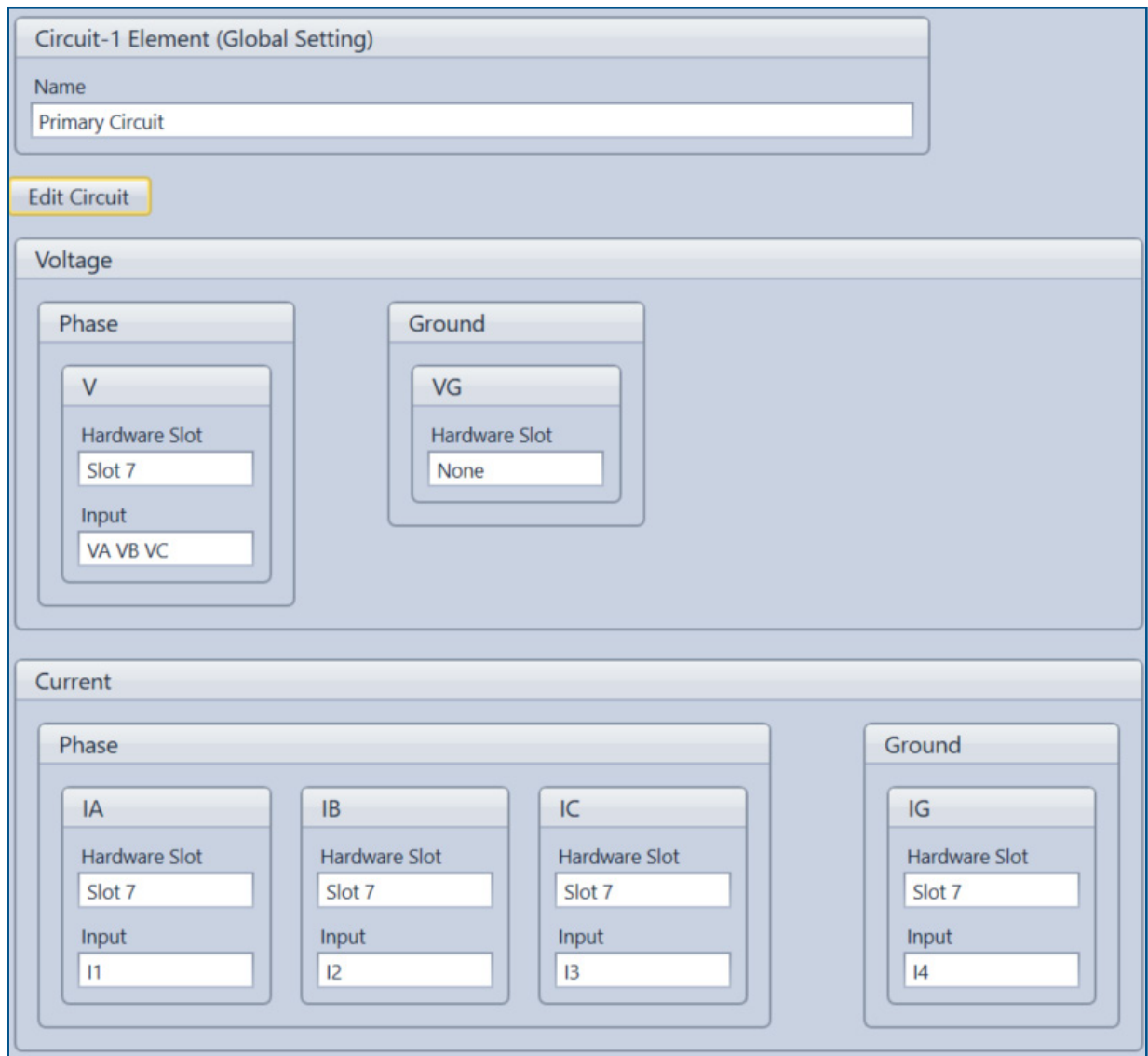


Figure 4 - Circuit-1 Element Configuration

Circuit-2 Element (Global Setting)

Name

Voltage

Phase

V

Hardware Slot

Input

Ground

VG

Hardware Slot

Current

Phase

IA

Hardware Slot

Input

IB

Hardware Slot

Input

IC

Hardware Slot

Input

Ground

IG

Hardware Slot

Input

Figure 5 - Circuit-2 Element Configuration

Now that we have both independent analog signals into the BEI-FLEX and configured as circuits, there are a few things we can do with it. The manual method is to utilize the metering of the BEI-FLEX to view each circuit to ensure they match. The fully automatic method is to use the configurable math element capabilities of the BEI-FLEX to subtract one measurement from its respective pair. For example: Subtract phase A current measured

by slot 7 from the same phase A current by slot 6. If this value is not near zero (accuracies of the measurement need to be included in the setpoint), then it is clear that one of the other boards has an error. Be sure to set one threshold for positive difference and another for negative. If phase angle is also desired, you can add another element set to the Positive Sequence (I1 or V1) to incorporate angle into the equation.

Figure 6 - ConfProtection-1 Element Configuration

Figure 7 - ConfProtection-2 Element Configuration

Now that the BEI-FLEX has a protective element(s) that will trigger from an analog measurement or accuracy error, the user can decide whether they wish to trigger an alarm output, disable all protection as the measurements are unreliable, or other actions. The protective element is a regular protective function that can be incorporated into logic as desired. An example is shown in Figure 1.

Conclusion

With the BEI-FLEX, the analog measurements can be validated for accuracy hundreds of times per second. It can eliminate a possible introduction of error due to testing. This leads to a more reliable system at a lower cost, with very little incremental initial cost to the application. An extra board, protection package D or greater, and a little extra wiring on the back of the relay are all that is needed.

For Another Discussion

Contact inputs and outputs have similar, yet different issues. Unlike analog I/O, a contact I/O may not operate for years and therefore cannot be easily validated. The BEI-FLEX has a number of functions that can eliminate the need for injection testing to be discussed later.

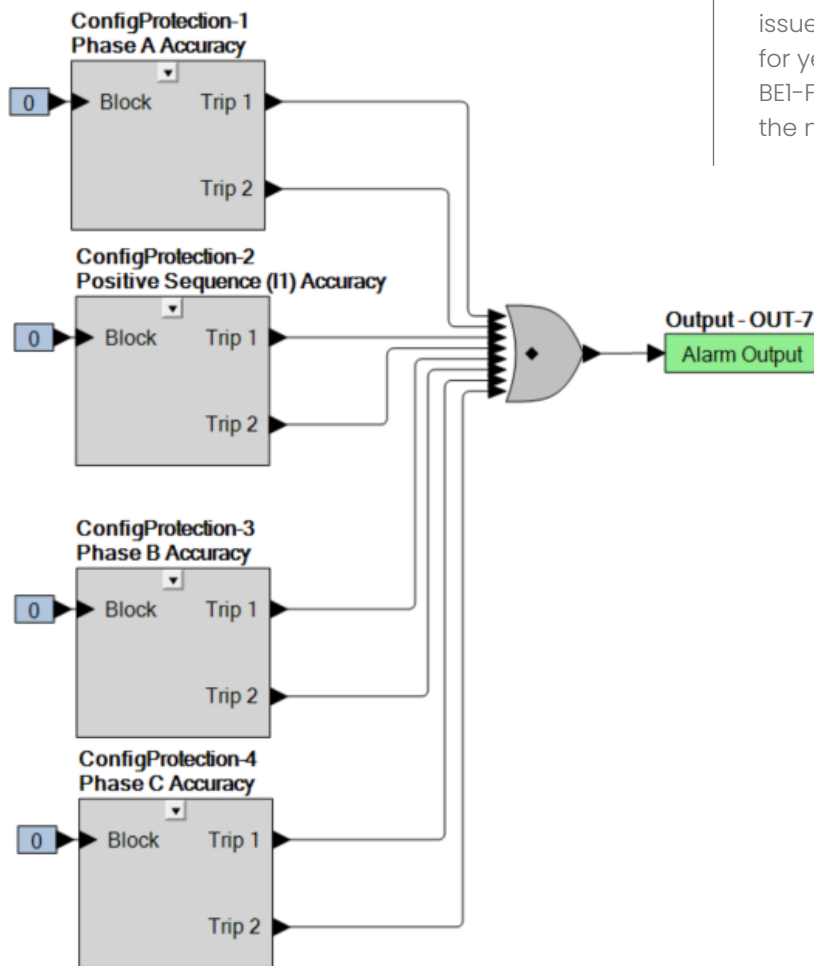


Figure 8 - Logic Example