Keeping the Electricity flowing in Southern Africa

CAHORA BASSA PROJECT

Bergoz Instrumentation Current Transformers have been employed in an interesting application to detect faults in the electricity supply lines in Southern Africa. ABB successfully installed Bergoz CTs recently and the system described below is now operational in the field.

The Cahora Bassa dam and hydroelectric-power project on the Zambezi River is the largest hydroelectric scheme in southern Africa and supplies power to South Africa, Maputo city, Tete, and to coal mines and aluminium smelters in the region. The system includes two parallel 533 kV HVDC lines between converter stations at Songo in Mozambique and Apollo in South Africa, covering 1 400 km. The transmission lines pass through dense bush and difficult terrain and were sabotaged during the Civil War in Mozambique but have since then been rebuilt and refurbished.

Heavy rains and tropical storms are a constant threat to these vital transmission lines.
Rainfalls and severe floods during February 2000 in the Limpopo River valley again caused considerable damage to both lines to the extent that about 10 towers collapsed and needed to be reconstructed to restore the power supply to South Africa.

Now ABB has installed sophisticated fault location equipment in order to be able to locate a fault along the long and remote line sections and to dispatch a repair team as fast as possible.

The fault location equipment is part of the control and protection system called MACH2, where all functions for control, supervision and protection of the stations are implemented in software running in a family of microprocessor circuit boards. The industrial PC based system has tailor made I/O board interfaces to the different field units. The PC computers are used for the control and protection functions and there is also an HMI system with control images and alarm/trend windows.

Line Fault Location

The DC Line Fault Locator (LFL) detects temporary or permanent DC-line faults, calculates the fault location and generates a message to report the date, time, pole and fault location automatically.

Principle of Operation

When a line fault occurs, travelling waves propagate in both directions away from the fault point. Satellite-synchronized clocks (GPS) are used in each end of the monitored line for absolute time marking of the arrival of the first incoming wave front.

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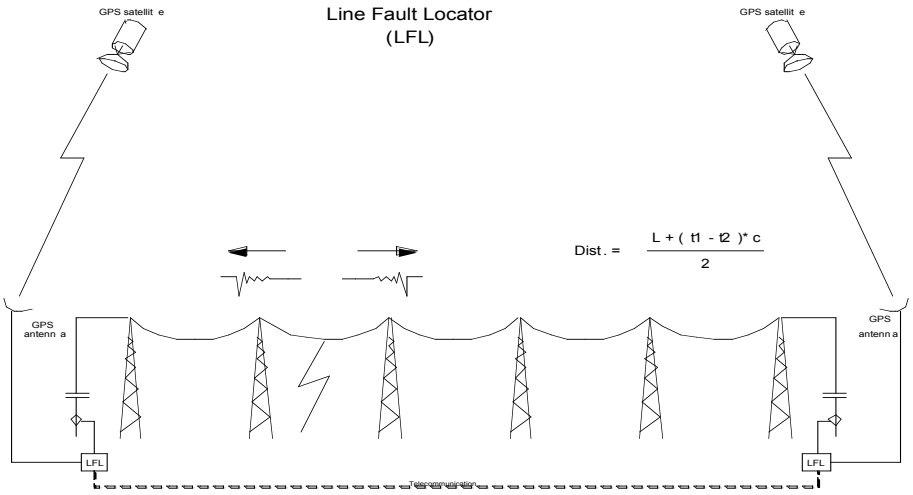

Figure 1: Principle of operation/calculation

The LFL computer (MACH 2) in each station reads the arrival time in the GPS clock. Then the LFL computers communicate the respective event with each other. They are then able to calculate the location of the fault using the time difference between the arrivals of the event.

Figure 2: LFL cabinet showing position of the CT

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LFL SYSTEM DESCRIPTION

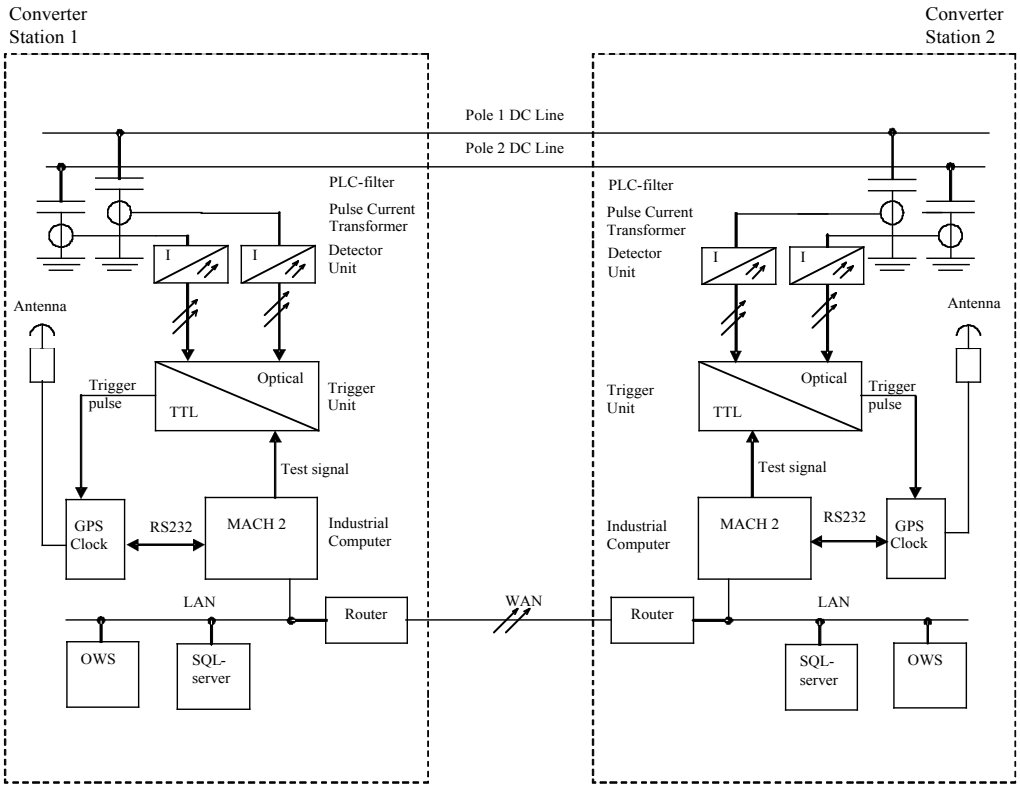

Figure 3: System Block Diagram

Travel Time Surge Front Detection

After a DC line fault, the LFL detects the first pole mode voltage drop caused by the arrival of the transient (surge front).

Current Derivative Measurement

The PLC coupling capacitors are equipped with CTs used as pulse transformers connected to a passive detector unit that compares the high derivative signal caused by the pole mode voltage drop with a preset trigger level. The detector triggers on either the positive or the negative slope, making it independent of line polarity.
When the derivative detector has detected a surge, it immediately sends a signal via fibre-optic link to the trigger unit in the control room.
The pulse transformer and the passive detector unit are separate for each pole line. The trigger unit signal is fed to the GPS clock to provide an absolute time marking of the arrival of the first wave front.

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Fault location and accuracy

The fault location is calculated as a distance, in km, from the converter station. The distance can then be made to correspond by the system to a tower number id. The tower number information is a part of the Station Control and Monitoring system SQL database.
To achieve the desired accuracy, final calibration of the LFL is done by means of staged dc line faults at various locations.
The LFL computer in each station reads the wave front arrival time time-stamped by the GPS. In order to calculate the distance to the fault it communicates the respective event to its “other end” LFL via telecom links or, if the telecommunications are not operational the trigger time must be retrieved manually from each location.

Acknowledgements

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