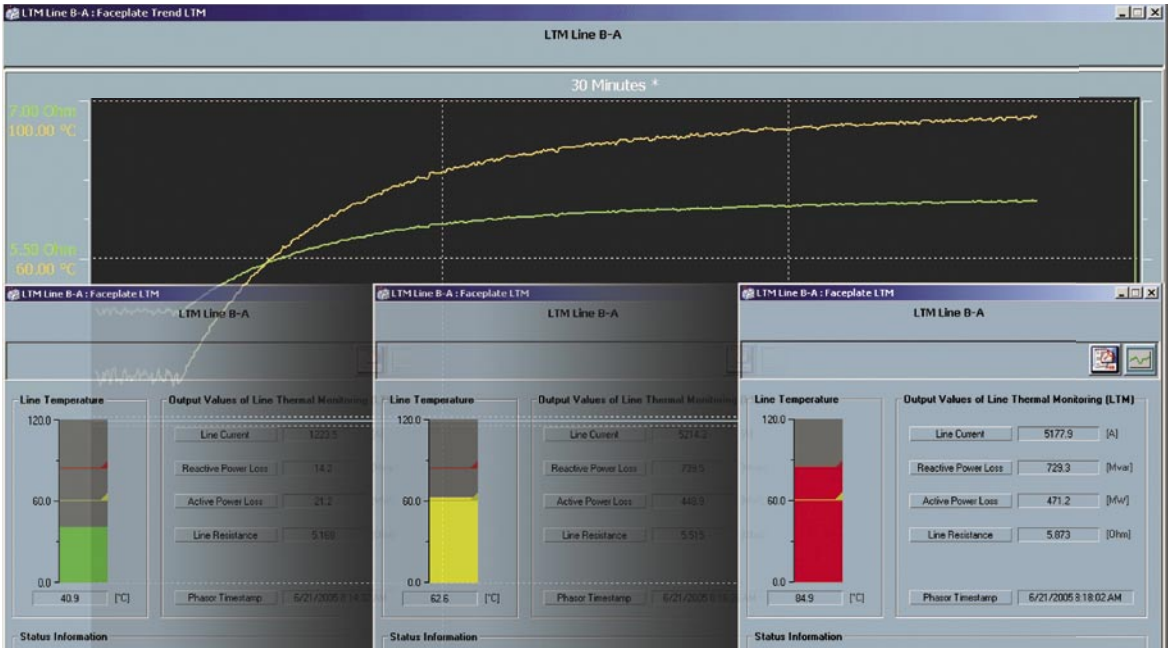
Line Thermal Monitoring— dynamic rating of transmission lines

A PSGuard Wide Area Monitoring System application.



Application

Due to the high cost of new transmission circuits as well as transmission bottlenecks, the static thermal ratings of transmission lines are now being challenged by many utilities as overly conservative. As an alternative, ABB offers the utilities an application of real time thermal rating of the transmission lines as an option to access and increase the available transfer capability of the transmission circuits. Properly applied, this technology will provide accurate information about thermal conditions of the transmission circuit. Dynamic rating of a transmission line is considered to be a smart cost alternative to the addition of a new transmission line without risking the thermal overheating of an existing transmission line.

The main intention behind developing Line Thermal Monitoring (LTM) has been to monitor and display the actual situation regarding thermal stability of a transmission line. The operator can decide about the loading based on the actual on-line transmission line temperature provided. This enables less conservative loading of the power system; in other words, to transfer more load and still not thermally overload the line.

Function

The function of the LTM application is the online average line temperature calculation based on phasors measured at both ends of the transmission line.

For Line Thermal Monitoring there are no additional sensors necessary along the corridor. With phasor measurements taken by two Phasor Measurement Units at the beginning and end of a transmission line, LTM is the most cost effective solution for investment and operation. Typically, no costs are incurred for the transmission of the measurement values.

The algorithm provides an operator with precise outputs every second. It works as follows:

- The voltage and current phasors measured at both ends of a line are collected by GPS synchronized PMUs
- Actual impedance and shunt admittance of a line are computed
- Resistance of the line/cable is extracted
- Based on the known properties of the conductor material (reference temperature and dependency coefficient are usually supplied by the manufacturer), the actual average temperature of the line is determined.

Typically wind speed and direction, ambient temperature and sun emission do influence the line resistance directly, making it necessary that all these essential temperature factors must be measured additionally. The LTM algorithm takes all these effects into account by directly measuring the resulting impact in the form of the line resistance and calculating the actual temperature.

The temperature obtained is the average over the line in contrast to using local measurements of hot spots. This makes it possible for the operational personnel to take fast decisions in an emergency case, because they do not need to interpret the results of multiple single measurement values spread all along the transmission line, but can rely on the precise output of one single application–LTM.

Furthermore LTM provides operators with information about the present line resistance as well as active and reactive line losses, so that a very precise model of the power grid is generated and the operator can assess the present situation much better. User defined warning and alarm levels can be set online, as a significant help in detecting overheated lines.

LTM works as a support tool for reducing the impact of unavoidable disturbances by warning before local protection tools might trip an overheated line. The results of the LTM application are visualized with the PSGuard Basic Monitoring module and can additionally be integrated in SCADA EMS / Network control systems with RTU live interfaces.

To analyze and reinterpret past temperature scenarios or events, historical data can be easily accessed in the PSG Database, where temperatures are stored with a time resolution of one second. With the export module included, the user can export historical data as CSV files offline, which can then easily be imported into business applications such as Excel.

Online output provided

- Display of actual line average temperature either in °Celsius or °Fahrenheit
- Display of temperature changes as trend, updated every second
- Display present line resistance
- Display of active and reactive line loss
- Display of line current
- Assessment of thermal limits based on measured and design parameters of the line
- Assessment of transmission line loadability
- Online warning and emergency alerting

Offline output provided

- Access to historical data
- Data export to business applications such as Excel

Benefits

- Provides operators with a good estimate of the average temperature, the present line resistance and line losses (active & reactive)
- No sensors along the corridor necessary: Measurement sensors at beginning and end of the line
- Cost effective solution for investment and operation by using measurement equipment in substations
- Risk reduction by performing measurements not directly at HV potential, no influence of electrical fields
- Short measurement intervals for fast identification of critical temperature level (Output updated every second)
- Possibility for the operating personnel to take fast decisions by giving one average temperature instead of multiple measurement values
- Possibility to set feasible warning and alarm levels
- Direct integration in SCADA EMS / Network Control systems

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