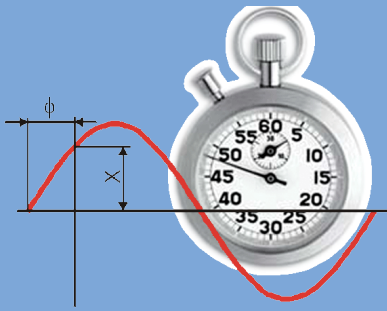


# Synchronous Measurement

Support for Smart Grids  
by AIS Brno



## POWER GRID STABILITY



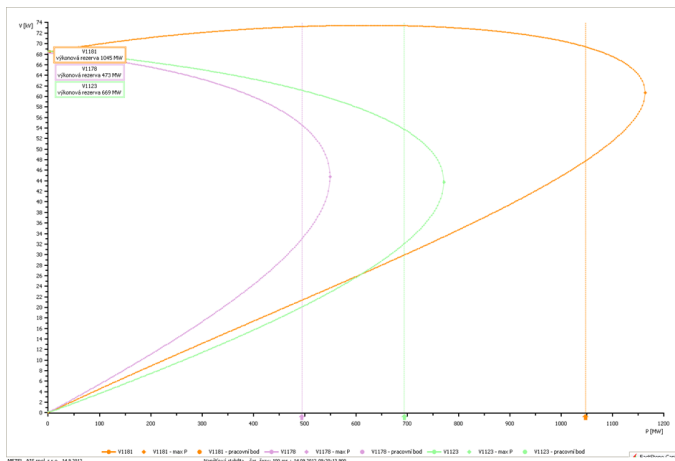
### Features:

- Continuous evaluation of network stability from the following point of view:
  - Voltage stability.
  - Static stability.
  - Critical oscillations of power and frequency.
- Alarms or early warnings in the case of exceeding or approaching of preset limits.
- Calculation of static stability of system defined as ability to achieve a new, stable state in the slowly changing conditions.
- Monitoring of frequency and power oscillations.
- Monitoring of voltage stability.

### Application benefits:

- On-line evaluation of critical state of power grid.
- Early warning, generation of event in exceeding of preset limits.
- On-line information about parameters and reserve in utilization of important lines.
- Monitoring of voltage stability, creation of live P-V diagram with preset limits and generation of event in exceeding of preset limits.
- Monitoring of reserve of static stability, creation of live  $\varphi$ -P diagram with preset limits and generation of event in exceeding of preset limits.

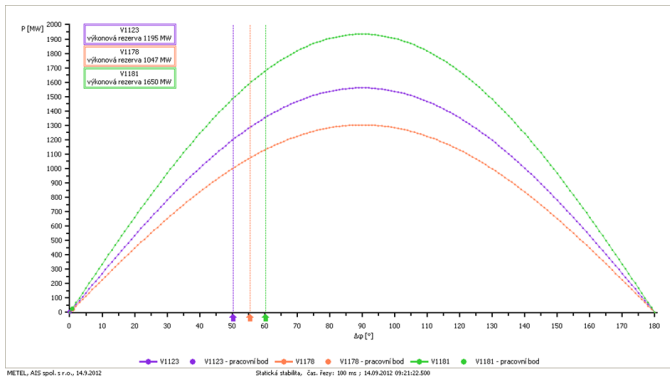
### Example P-V diagram with preset limit:



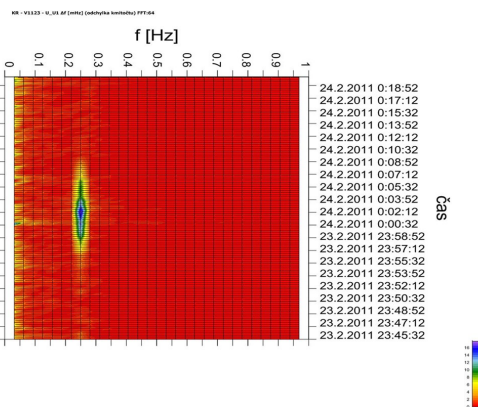
### AIS spol. s r.o. background:

- Founded in 1990 in Czech Republic.
- Employees with experience of 40 years in power engineering.
- Czech Republic no. 1 in synchronous measurement - over 700 measured nodes in over 140 electrical substations with AIS terminals.
- Experience staff in the following fields:
  - WAM systems development and implementation.
  - PMU development and programming.
  - Communication equipment development and programming.
  - Concentration of communications and conversion of communication protocols.
  - Data processing.
  - Database and client SW development.

## Example $\phi$ -P diagram of static stability:



## Spectral analysis of frequency oscillations:



## Terminal - Phasor Measurement Unit (PMU) specification:

- Stand alone unit with in-place compute functions, storage option and remote parameterization.
- Fast parallel measurements — typically 10 kHz.
- Various measurement inputs for range of instrument transformers.
- 8 inputs per terminal.
- GPS time synchronization - phase precision < 0.1°, voltage and currents precisions < 1%.
- Wide range of communication options on physical layer (Ethernet, RS-232, GSM/GPRS) and standard protocols (e.g. IEC-68570-5-101/103/104, IEEE-C37.118) implemented.
- Conforms to EMC standards for industrial environment.

## Distributed synchronous measurement in electrical networks:

The quality of data obtained from measurement in electric networks of all levels is affected, apart from other influences, by time diversity of individual information. Result of this is limit of exactness of such data sets analysis. Synchronous measurement, namely the measurement of synchrophasors, represents possibility how to reduce or eliminate these errors. Data obtained by synchronous measurement represent significant input for the new trends in dispatcher control of distribution networks.

The need of reliable electricity supply poses high claims to modern systems of network control, to support systems and to software tools for secure, effective and cost optimal network control. The control is based on status vector of electric network. Available redundant measurements are used for estimation of this vector, i.e. voltages, currents, real and reactive power. However, the calculation algorithms are valid only for simultaneously measured data. The inexactness of measured quantities comes from errors of individual parts of measuring chain in the switching station control system. Another source of errors is asynchronous measurement of measured quantities and data delay in communication lines. All these errors mean aggravation of exactness of calculations.

Relative phasors between network nodes are specific variables. Methods of their measurement are synchronous by principle and they are not dependent on the error of amplitude. The demands on their quality differ according to the way of their utilization.

Optimization of utilization of distribution networks with high load raises need of real time knowledge of actual steady operation and dynamic transitions. Asynchronous real time measurement brings considerable errors to subsequent control processes and control system calculations. Devices for synchronous measurement of voltage and current phasors, improved communication between objects and dispatching centre and powerful computer hardware represent the solution of these problems.

Synchronous measurement plays key role for the estimation of high voltage network. Practical experience shows that delay of information concerning changed measurement can significantly damage the results of estimation. The benefit of expanding the measured group by voltage synchrophasors is possible to evaluate by comparative calculation of estimation criterion. Adding of several number of phasor measurements can significantly reduce consequences of traditional asynchronous measurement.

Wide Area Measurement Systems (WAMS) represent new way how to solve power transfer and distribution problems. These systems are intended for monitoring of wide networks by extensive measurement of synchronous phasors in crucial network points. WAMS consist of network of GPS synchronized Phasor Measurement Units (PMUs), system of data transfer and collection using various types of communication similar to that of SCADA systems, data storage and processing and collection of applications performing on-line and off-line data presentation or consequent processing.

Particular applications can perform important tasks like monitoring of network stability, early fault warning, support of switching, evaluation of power quality etc.



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