

Network analyzer

Monitoring power quality to ensure optimum operation

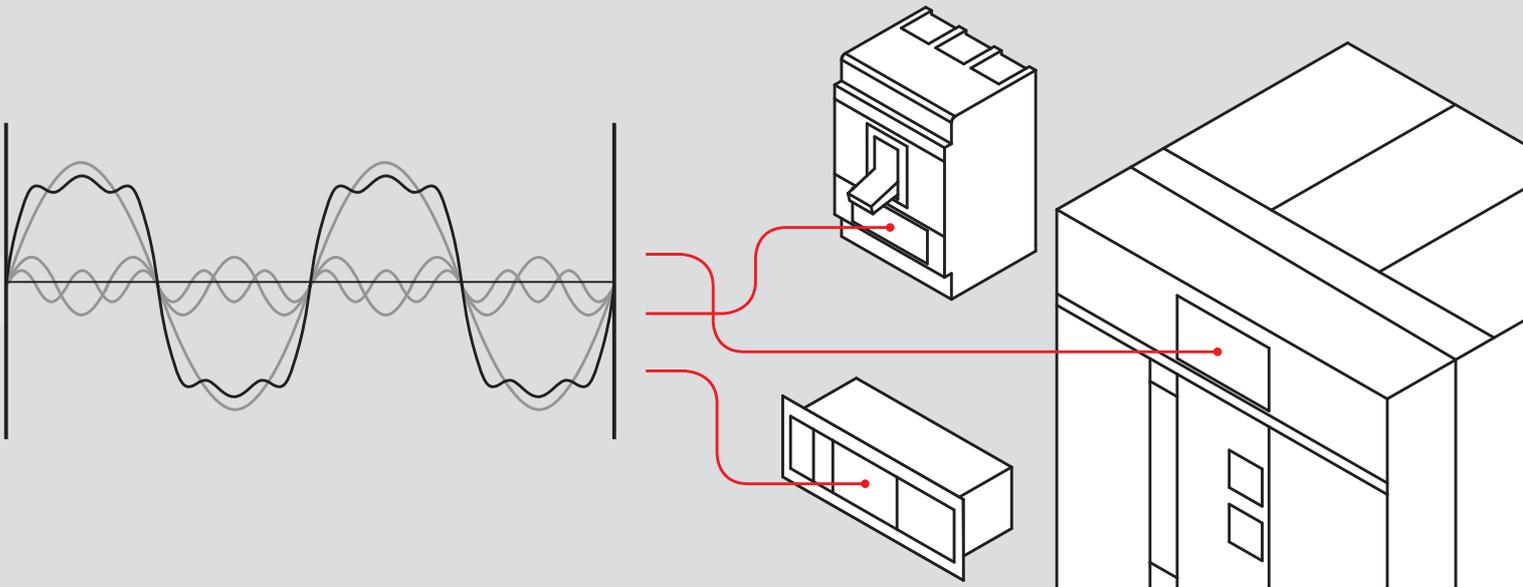


ABB Ekip electronics offers embedded Network Analyzer function to understand the power quality in low-voltage plants.

This innovative capability is built-in inside Emax 2 or Tmax XT circuit breaker and Ekip UP+ digital unit to manage electrical systems according to IEC 61000-4-30 and IEEE's 1250 *Guide for Identifying and Improving Voltage Quality in Power Systems*¹.

Power quality

Voltage is the input of every electrical appliance: countless travelers face this point every year, for example, when travelling from 230V/50Hz Countries to 120V/60Hz ones.

Electrical equipment is designed for optimum operation under a smooth, constant voltage level as close as possible to the rated value. In addition, industrial equipment, working on three-phase supply, requires the three phase voltage levels to be equal (balanced).

Power quality (PQ) is a description of how well a power system complies with the above ideal conditions. Deviations, i.e. power quality issues, can have negative consequences on the components and on the energy efficiency of the network as a whole.

Thus, power quality monitoring is becoming more and more important with modern power systems, and will be a key part of the smart grid of the future. In detail, power quality evaluation includes the following aspects:

- Deviations of the voltage average value from the rated value
- Short interruptions and spikes of power supply
- Short decreases (sags) or increases (swells) of voltage value
- Voltage unbalance, i.e. difference in voltage values between different phases
- Presence of current and voltage harmonics.

Standards mandate specific PQ requirements. Different Standards may be applicable to different kinds of installation. For power distribution, the most widely used Standards are EN50160 in the IEC world and IEEE 1250 in the UL world. A more specific example is the ITI (formerly known as "CBEMA") curve, which summarizes voltage sags and swells that data processing equipment can tolerate.

¹ Network Analyzer built-in inside Ekip units is compliant to IEEE 1250-2011, Section 3 for the monitoring of voltage value, unbalance and harmonic content, which is the equivalent of IEC61000-4-30 Class S for voltage value and unbalance and Class B for harmonic content.

Application examples

Distortions of voltage value (sags, swells) and/or frequency can have fatal consequences, especially for process industries: production stopping with consequent expensive downtime, damages to motor drives and damages to PLCs are just some examples.

Examples of process industries that can be badly hit by voltage instabilities include plastics, petrochemicals, textiles, paper, semiconductor, and glass.

Voltage sag is defined as the case when the value of the voltage is reduced below the rated one for a certain amount of time.

Single line-to-ground faults (lack of insulation or short-circuit between one phase and ground) on the utility system are a common cause of voltage sags. These kinds of faults are often caused by lightning, ice storms, falling tree branches and animals.

The voltage on the faulted phase goes to zero at the fault location and the voltage drop on loads in the area will depend on the location of the fault. The voltage sag condition will last until the fault is cleared by a protective device (fuse, breakers).

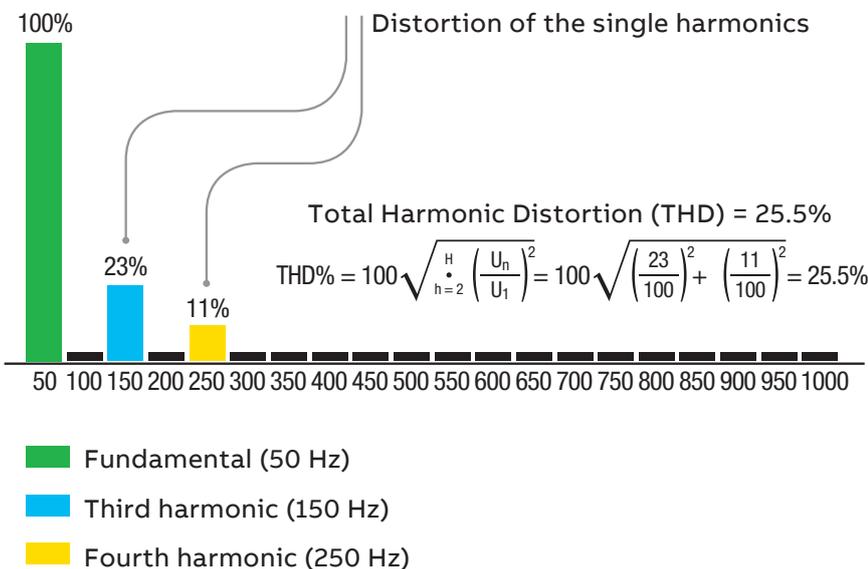
Another common cause is the start-up of large loads, inside or outside the installation.

Similarly, voltage swell is defined as the case when the voltage is increased above the rated value for a certain amount of time.

Thus, RMS value and frequency of the voltage are two fundamental features of a voltage signal, but the “purity” of the voltage waveform is also an important point. An ideal voltage waveform should be a perfect sinusoid, but this does not usually occur in the real world.

Frequencies other than the fundamental one are always present. These frequencies are called harmonics: a harmonic of a signal is a frequency component of the wave spectrum that is a multiple of the fundamental frequency.

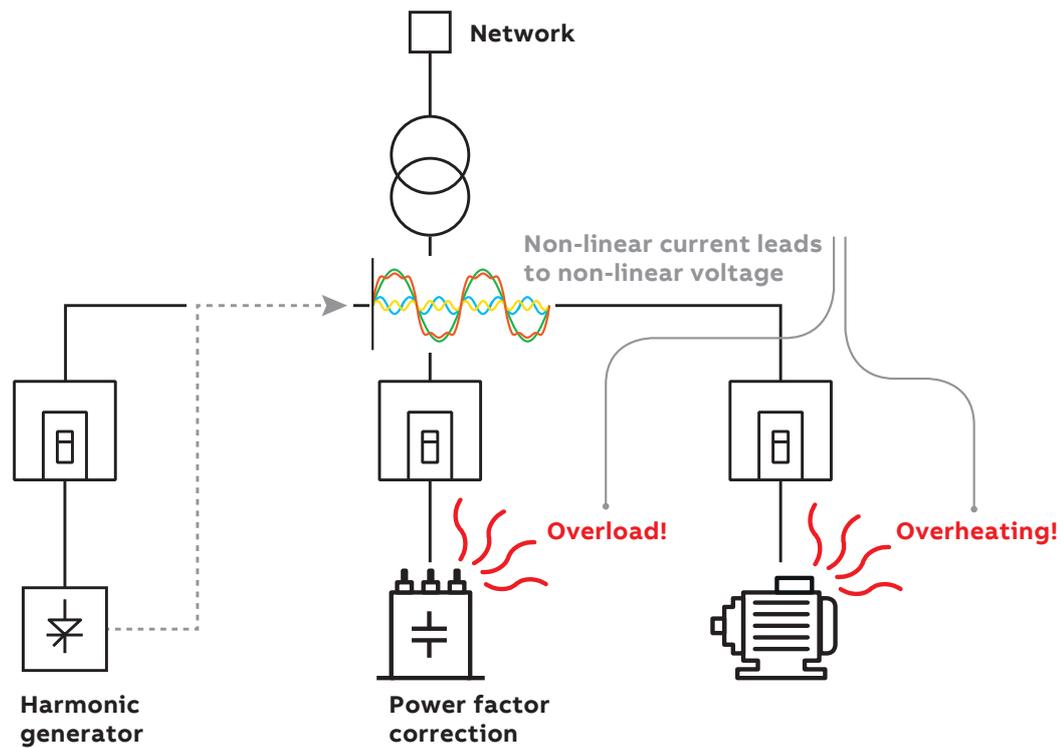
Harmonic content is an issue that is becoming increasingly debated: technological developments in the industrial and household field have led to the spread of electronic equipment which, due to their operating principle, absorb a non-sinusoidal current (non-linear load). Such current causes a voltage drop of non-sinusoidal type on the supply side of the network with the consequence that the linear loads are also supplied by a distorted voltage.



To get information about the harmonic content of voltage and current waveforms and to take measures if such values are high, a dedicated index has been defined.

The Total Harmonic Distortion (THD), of a signal is a measurement of the harmonic distortion present and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.

The presence of harmonics in the electrical network may be the cause of equipment malfunctions, such as overloading of the neutral conductor, an increase of losses in the transformers, disturbances in the torque of motors, etc. In particular, harmonics are the phenomenon that most heavily power factor correction capacitors.



- 01 Tmax XT
- 03 Emax 2
- 04 Ekip UP*



Benefits

Measurement of PQ is the first step for checking the status of the installation and starting the root cause analysis.

Using Ekip Hi-Touch trip units or all Ekip UP+ versions as a power quality monitor is a very interesting option, just considering:

- The ease of use as the power quality functions are already programmed inside the unit.
- The wide choice of communication protocols as the information about power quality can be transmitted via several protocols, embedded in the Ekip units.
- The cost-effectiveness as voltage sockets are already embedded inside the units and no more voltage transformers have to be purchased, reducing wiring requirements.

Parameter	Description
Sag Threshold (First Class)	Defines the first alarm threshold. It is expressed as % Un.
Sag Times (First Class)	In the event of dropping under the first alarm threshold, it defines the time beyond which the alarm counter is increased.
Sag Threshold (Second Class)	Defines the second alarm threshold. It is expressed as % Un.
Sag Times (Second Class)	In the event of dropping under the first alarm threshold, it defines the time beyond which the alarm counter is increased.
Sag Threshold (Third Class)	Defines the third alarm threshold. It is expressed as % Un.
Sag Times (Third Class)	In the event of dropping under the first alarm threshold, it defines the time beyond which the alarm counter is increased.

The Network Analyzer function allows also the user to set controls on voltage in order to analyze the operation of the system: any time a control parameter exceeds the preset threshold, an alarm is generated.

All the following parameters are continuously monitored:

- Hourly average voltage value
- Short voltage interruption
- Short voltage spikes
- Slow voltage sags and swells
- Voltage unbalance
- Harmonic analysis

Referring to the voltage sag ambit, as an example, the Network Analyzer function gives the possibility of controlling three kinds of sag classes, defined by the user.

Two different types of counters for each power quality monitoring function are available directly on the trip unit touch screen: one is a cumulative counter, that stores all the alarms (for example, all the voltage sags) since the beginning, and another one is a 24h counter, that shows the alarms in the last 24 hours.

With the optional communication module (Modbus, Profibus, Profnet, etc.) eight counters for each power quality monitoring function are available: one is the cumulative and the other seven are the daily counters of the last seven days of activity.