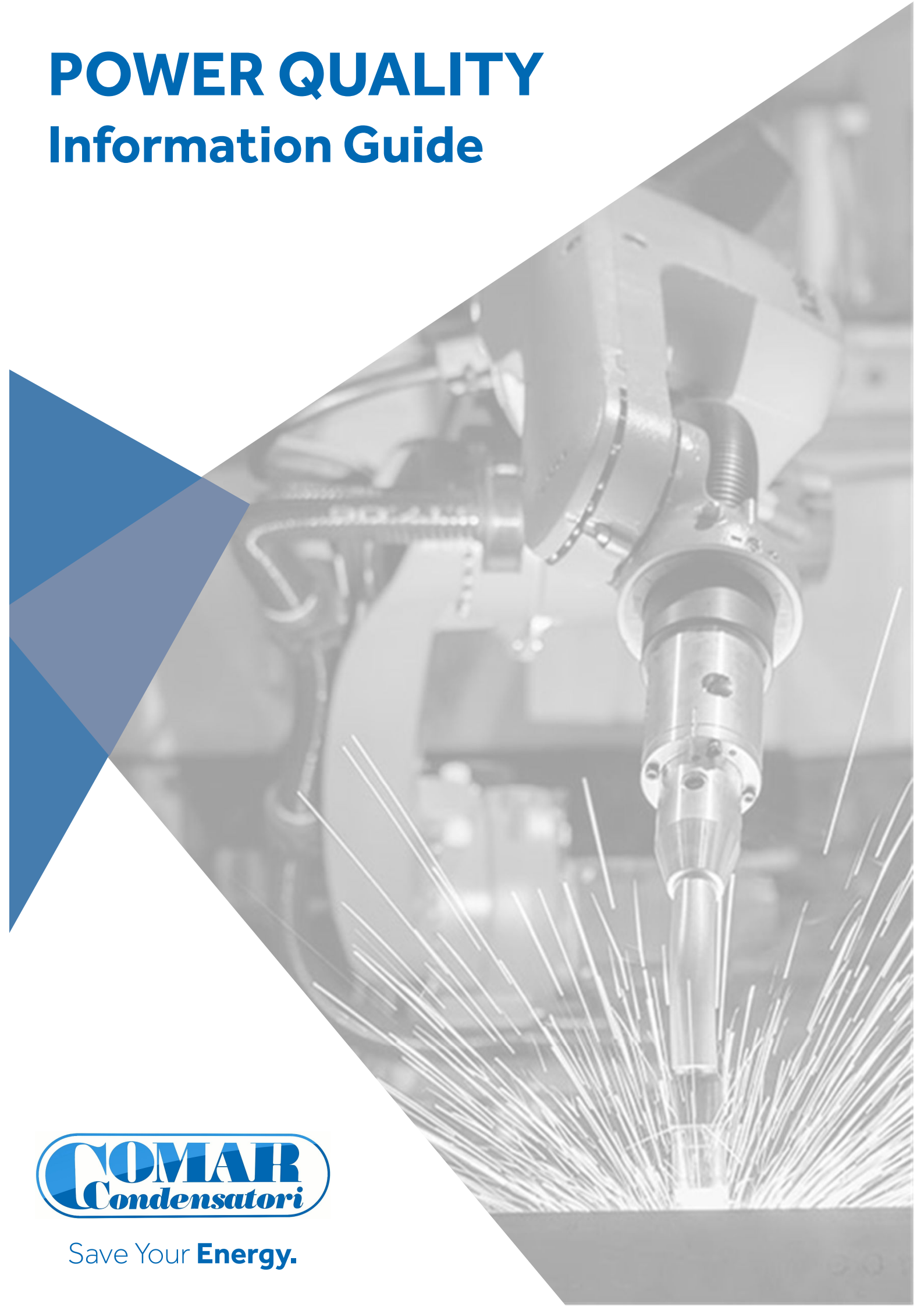
POWER QUALITY
Information Guide



COMAR Condensatori

Save Your **Energy.**

For some years now, many types of applications (e.g. water treatment, maritime sector...) have shown increasing implication with Power Quality: if, on the one hand, the user demands a certain quality of energy from the power distributor, without however being able to negotiate it, on the other hand, the loads used in the production process can negatively affect the electrical system, reducing - even drastically - the quality of the energy consumed.
Therefore, the company that wants to make the most of its energy, and therefore save money, must take action, analyzing the situation of its system and carrying out interventions to improve power quality.

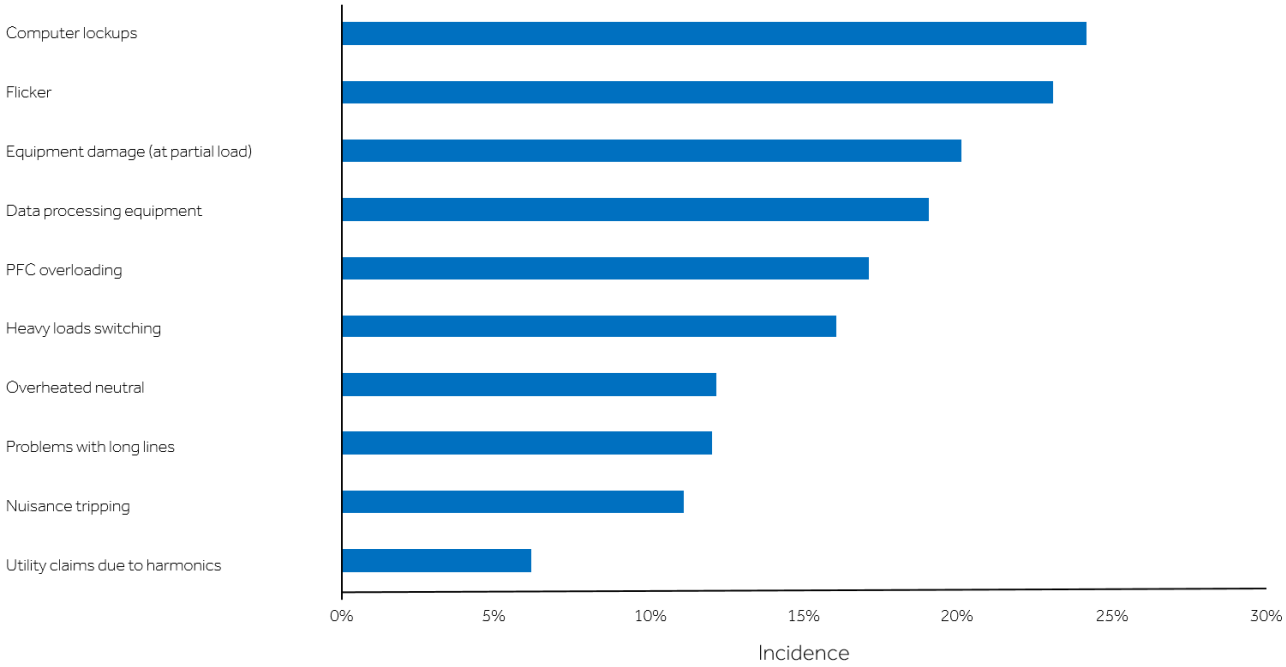
Deciding to entrust **COMAR Condensatori S.p.A.** an in-depth network measurements in this regard not only allows to identify the most reliable solutions, but also to avoid the most critical problems that can lead to failures of the production equipment and, in some cases, even to the interruption of the entire production cycle.
Insufficient electricity quality therefore affects the efficiency of the whole system, its availability, the quality of the work, the reliability of the machinery, safety, and ultimately the operating costs.
«Energy quality» means:

- continuity of power supply, namely the absence of interruptions in the supply of the electricity service
- The quality of voltage and current, namely the quality of the waveform (amplitude, frequency, variations, etc.).

There are many factors that affect the quality of electricity and in particular those attributable to the distributor, such as the management of the network and its correct maintenance, and those dependent on the user, such as faults at the user's plant and disturbances emitted on the network (then there are problems caused independently of the responsibility of one or the other, or in the presence of environmental factors and atmospheric events that cause damage as important as it is unpredictable).

In recent years, the growing diffusion of electronic equipment based on microprocessor controls, or the spread of power electronics tools, used for energy management and production control, has contributed significantly to increasing the disturbances undergone by the electrical quantities.

The following graph provides an overview of the most frequently occurring power quality problems (Source: European Copper Institute).



Of course, poor power quality is not the cause of all the problems listed (for example, computer freezes may be related to abnormal software interruptions).

Since power quality problems are different, this brief informative guide tries to describe them so as to understand how to identify and solve them.

Power Quality Problems & Solutions

The **power factor** is essential for power quality as, if optimal, it regulates excessive reactive power and reduces unnecessary currents, as well as voltage drops.

This also implies a reduction in losses due to the joule effect and therefore the immediate improvement of the lines and components that make up the system: in fact, the load of the transformers and lines is reduced, and it is possible to avoid oversizing in the design or expansion phase.

Installing suitably sized capacitor banks is therefore the first step to take into consideration, requesting power factor correction equipment with blocking reactors in the presence of harmonics.

Harmonics are disturbances, in voltage and in current, which distort the original shape of the sinusoid, and have a frequency that is multiple with respect to the fundamental frequency (e.g. n x 50Hz).

These unwanted frequencies cause numerous symptoms, including overheating of the neutral conductor (see effect of the third harmonic) and of the power transformers that power these circuits. Harmonics originate from the action performed by non-linear loads, such as static converters, variable speed drives, arc welders, controlled diode power controls, etc. In overall terms, current harmonics are capable of reducing the efficiency of an electrical system, damaging its insulators - on lines and utilities - and creating operating anomalies on various components. When symptoms related to harmonics occur, it is necessary to carry out a measurement campaign observing the total harmonic distortion (THD). A significant increase in THD with varying load conditions allows to establish a comparison in percentage terms of the current level of each individual harmonic with respect to the total current flow of the fundamental in the system. Knowing the effects caused by each harmonic current and comparing them with the symptoms identified helps to troubleshoot. The origin of the harmonic must therefore be isolated and resolved through the appropriate installation of harmonic filters.

Power frequency variation is, in fact, an alteration of the mains frequency with respect to the nominal one. As an average value, the Norm assumes that measured within a 10-second interval.
The European frequency of 50 Hz must remain within a tolerance of ± 1% for 95% of the year of supply, while, at any time, it must not exceed an increase of 4% or a decrease of 6%. What is at the origin of a frequency variation are the failures in the generation and transmission system, or even the sudden shutdowns of large generators. The negative effects are manifested in terms of speed variation of the motors and possible functional anomalies on electronic equipment.

The **transient** (impulsive / oscillatory) is a temporary voltage variation of an electrical circuit, due to a disturbance, caused by operating overvoltage or currents in the series inductances.
Voltage transients can cause symptoms ranging from computer lockup and damage to electronic equipment, to the occurrence of discharges and damage to the insulation of distribution equipment. They manifest themselves with considerable voltage increases, with a duration equal to only a few microseconds and are often caused by lightning and by the anomalous switching of capacitor banks, or by the return to operation of systems after a power failure, by the switching of loads consisting of motors, the switching on or off of loads consisting of fluorescent lamps or high intensity discharge lamps, the switching of transformers or finally the abrupt stop of some types of equipment.
In the presence of transients, it is necessary to monitor the load in order to associate operating problems or equipment failures with the events that occur in the distribution system.

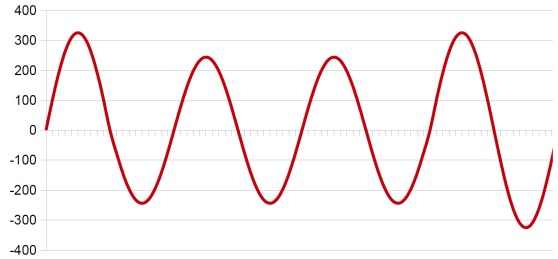
The **flicker** is a phenomenon produced by the sudden and repetitive variations of the voltage. The causes can be various: connection and disconnection of large loads, motor starting, arc furnaces with high-powered crushers, as well as the use of welding systems or converters.
Depending on how dynamic the load variations are, the compensation power can be provided through dynamic compensation systems and / or active filters. In any case, for the dimensioning of a flicker compensation, a measurement of the load trends in the short term is necessary.

Voltage imbalance is one of the most common problems in electrical networks and occurs when a phase is excessively loaded assuming a lower voltage value than the other phases.

Being often neglected, imbalances can cause serious damage to electrical and electronic equipment, especially transformers and three-phase motors which, in the presence of asymmetries, could be subject to problems of overheating, abnormal noise, excessive vibrations and premature failures. . In fact, in a motor with a voltage of 400V, apparently contained voltage imbalances (2-3%), cause a current imbalance that can exceed 20%, with a temperature rise of over 30 ° C. In these cases it is necessary to have a voltage stabilizer, which detects and compensates for voltage imbalances automatically and independently on each phase.

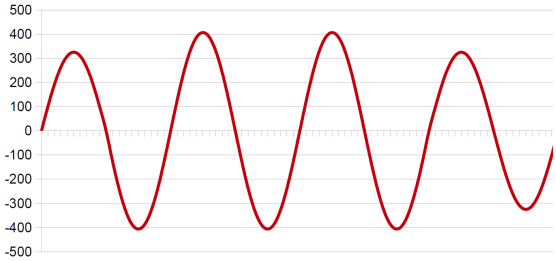
Voltage variations include voltage drops or rises and are resolved by installing a voltage stabilizer that guarantees an output voltage around the nominal.

Voltage dips (= sags) are responsible for most power quality problems and occur when the voltage drops below 90% and up to 10% of its rated value, as below 10% it becomes an interruption.



Among the most common symptoms of sags are dimming of incandescent lights, computer lockups, shutdowns of sensitive electronic equipment, loss of data (memory) of programmable controllers and problems in relay control. In these cases, it is advisable to start by monitoring the load so that the symptoms of the drop occur first. If there is no correlation, move further upstream, until you can trace the origin.

Power surges (=swell, namely over 110% of the nominal value) occur less frequently, but can cause immediate breakdown of the equipment, often in the electronics power section. Some failures may not occur immediately, causing premature component failure.



Among the main causes of the jolts are the sudden shutdown of large loads and the anomalous switching of the power factor correction capacitors.

COMAR invests in Power Quality

The experience gained in the energy efficiency sector, as a leader in the design of the best power factor correction solutions, has allowed COMAR to come into contact with companies with high energy requirements, such as the steel, petrochemical, paper, packaging, concrete and automotive industry. Over the years, the need to provide complete expertise pushed COMAR to provide for other solutions, besides the well-capacitor banks, like harmonic filters. With a view to continuous improvement, the value offer is further expanded, thanks to the establishment of a team dedicated to Power Quality able to support companies with a series of tailor-made services, such as:

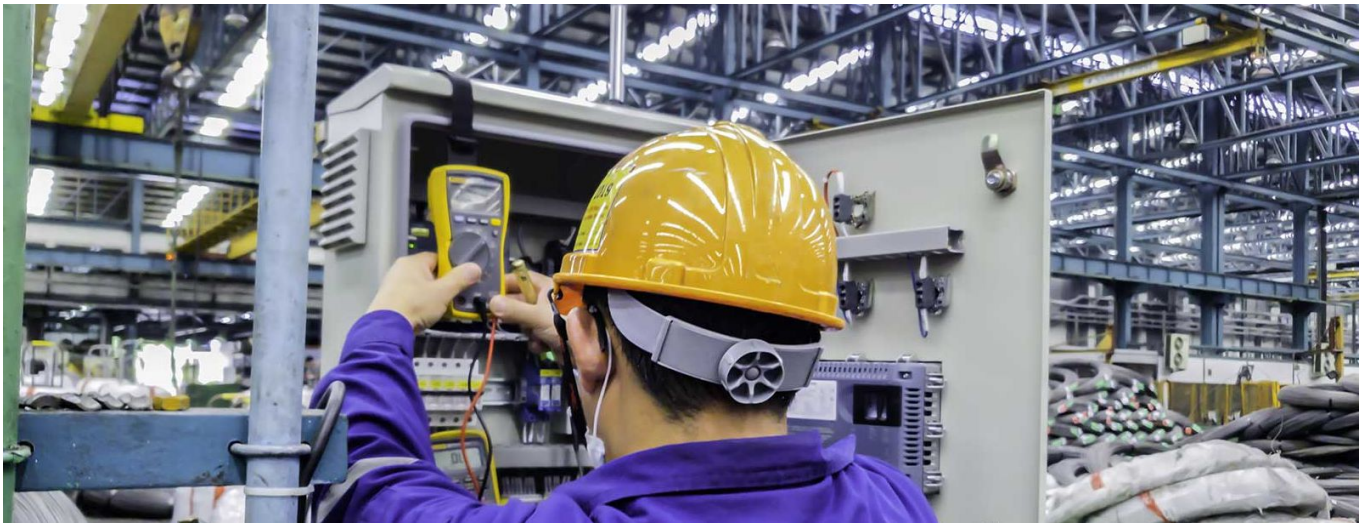
Power Quality Measurements and Network Analysis

- ✓ Harmonics of voltage and current
- ✓ Compatibility curves
- ✓ Unbalance of loads and voltage
- ✓ Active, reactive and distorting power
- ✓ Identification of anomalies, disturbance sources, definition of solutions

PQ Measurements with EN50160 test (recording duration of one week)

- ✓ Frequency analysis
- ✓ Variations in voltage
- ✓ Severity of the flicker
- ✓ Voltage imbalance
- ✓ Voltage harmonics
- ✓ Events of voltage, interruptions, dips and surges
- ✓ EN50160 report

Instruments used, depending on the type of analysis: class S or class A analyzer, according to IEC61000-4-30.



Do you have any other questions?

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