ELECTRICAL AND ELECTRONICS ENGINEERING

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EE 8006 – POWER QUALITY

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POWER QUALITY MONITORING AND CUSTOM POWER DEVICES

UNIT -5 INTRODUCTION TO MONITORING DEVICES
LECTURE 01
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POWER QUALITY MONITORING CONSIDERATIONS

It is a multi-pronged approach to identifying, analyzing and correcting power quality problems.

Helps to identify the cause of power system disturbances

Helps to identify problem conditions before they cause interruptions or disturbances, in some cases.
Objectives for power quality monitoring are generally classified into:

- **Proactive approach**
  - Intended to characterize the system performance.
  - Helps to understand and thus match the system performance with customer needs.

- **Reactive approach**
  - Intended to characterize a specific problem.
  - Performs short term monitoring at specific customers or at different loads.
PORTABLE MONITOR

PERMANENTLY INSTALLED FULL SYSTEM MONITOR

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This permanent monitoring system has the following components:

1) **Measurement instruments**
   - Involves both the voltage recorder and disturbance analyzer.
   - Has a trigger circuit to detect events.
   - Includes a data acquisition board to acquire all the triggered and sampled data.
2) **Monitoring workstation**

- **Used** to gather all information from the measuring instruments.
- Periodically send information to a control workstation.

3) **Control Workstation**

- This station configures the parameters of measuring instruments.
- Gathers and stores the data coming from the remote monitoring workstations.
- Does the data analysis and export.
4) Control software

- This software drives the control workstation.
- Does the analysis and processing of data.
- Algorithms used for processing varies according to the system used.
- Algorithms used may be based on wavelet transforms.
5) Database server

- Database management system should provide fast and concurrent access to many users without critical performance degradation.
- Also, it should avoid any form of unauthorized access.

6) Communication channels

- Selection of communication channel strongly depends on monitoring instruments, connectivity functions and on their physical locations.
CONFIGURATION OF REAL TIME POWER QUALITY MONITORING SYSTEM

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DATA ANALYSIS OF POWER QUALITY MEASUREMENTS

- Analysis is done by the control software and the method of analysis depends on the type of disturbance.

- Main objective of an analyzer is to identify the type of event.

- Analyzer looks for parameters in the measured data to characterize the waveform.
Since individual inspection of all wave shapes is not easy due to the large size of database, a few characteristics are extracted from the measured data, mainly magnitude and duration.

Since database has a lot of information and recorded data, analyzer extracts only the relevant disturbances.
METHODOLOGY OF DATA ANALYSIS

CONTROL SOFTWARE

Measure Duration

Disturbance Extraction

Classification

Measure Amplitude

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BENEFITS OF POWER QUALITY MONITORING

- Ensures power system reliability.
- Identify the source and frequency of events.
- Helps in the preventive and predictive maintenance.
- Determine the need for mitigation equipments.
- Reduction of energy expenses and risk avoidances.
HARMONIC DISTORTION ANALYSER

• Finding the harmonic distortion factor is most important for any circuit.
• Total harmonic distortion (THD) is the most useful technique to find the total harmonic-distortion for the current signal and voltage signals.
• THD can be defined as the ratio between RMS values of all harmonic signals to the RMS value of the fundamental signal frequency.
HARMONIC DISTORTION ANALYSER

Fig. 9.8 Harmonic Distortion Analyzer Using Bridged T-Network
HARMONIC DISTORTION ANALYSER

• The applied input wave is impedance matched with the rejection circuit with the help of an attenuator and an impedance matcher.

• This signal is then applied to a pre-amplifier which raises the signal level to a desired value.

• The following section consists of a Wien bridge.
HARMONIC DISTORTION ANALYSER

• The bridge is tuned to the fundamental frequency by frequency control

• It is balanced for zero output by adjusting the bridge controls, thus giving a notch in the frequency response of the rejection section.

• After the Wien Bridge, a bridge amplifier follows that simply amplifies low harmonic voltage levels to measurable higher levels.
HARMONIC DISTORTION ANALYSER

- A feedback loop is formed from Bridge Amp o/p to the Pre-Amp i/p thus eliminating even the slightest effect of fundamental frequency.
Flicker meters measure flicker in terms of the fluctuating voltage magnitude and its corresponding frequency of fluctuation.

Electric arc furnaces and arc wielding usually cause lights to flicker.

How to convert the voltage and the frequency of fluctuation into a standard parameter that defines the flicker limit becomes a problem.
FLICKER METER

IEC Flickermeter

New Strategy
Independent Voltage Adapter

- **Block 1** is the input voltage adapter, which scales the input half-cycle RMS voltage to an internal reference value.
- The primary function of this block is to allow flicker measurements be expressed as a percent ratio and become independent of the input voltage level.
Square Law or Quadratic Demodulator

• **Block 2** of the IEC flicker meter is a quadratic demodulator, which squares the scaled input in order to separate the voltage fluctuation (modulating signal) from the main voltage signal.

• This process simulates the behavior of an incandescent lamp.
Demodulator and Weighting Filters

- **Block 3** of the IEC flicker meter consists of three cascaded filters that serve to filter out components that have frequencies higher than that of the supply voltage.

- The DC component, produced from the square law demodulator.
a. Demodulator Filters
• First-order high-pass (cutoff frequency = 0.05 Hz)
• Sixth-order low-pass Butterworth (cutoff frequency = 35 Hz)

b. Weighting Filter
• Band-pass filter (models the frequency-selective behavior of the human eye)
Nonlinear Variance Estimator

• **Block 4** completes the eye-brain response model, as it consists of a squaring multiplier and sliding mean filter.

• The voltage signal is squared to simulate the nonlinear eye-brain response.

• The output of this block is an instantaneous signal proportionally related to the visual sensation of flicker.
FLICKER METER

STATISTICAL EVALUATION

• **Block 5** performs the statistical classification of the instantaneous flicker sensation, which is the output of Block 4.

• This output is categorized within an adequate number of classes.

• Then, a probability density function is created based upon each class, and from this a cumulative distribution function can be formed.
DISTURBANCE ANALYSER
DISTURBANCE ANALYSER

• Disturbance analyzers and disturbance monitors form a category of instruments that have been developed specifically for power quality measurements.

• They typically can measure a wide variety of system disturbances from very short duration transient voltages to long-duration outages or under-voltages.
DISTURBANCE ANALYSER

• Thresholds can be set and the instruments left unattended to record disturbances over a period of time.

• The information is most commonly recorded on a paper tape, but many devices have attachments so that it can be recorded on disk as well.
STATIC SYNCHRONOUS COMPENSATOR (STATCOM)

• STATCOM is a shunt connected, solid state device that uses power electronics to control power flow and improve transient stability on power grids (or power system network).

• It also regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from the power system.
• When system voltage is low, the STATCOM generates reactive power (STATCOM capacitive).

• When system voltage is high, it absorbs reactive power (STATCOM inductive).
STATIC SYNCHRONOUS COMPENSATOR (STATCOM)

- Variation of reactive power is performed by Voltage-Sourced Converter (VSC) connected on the secondary side of a coupling transformer.
- The VSC uses forced-commutated power electronic devices (GTOs or IGBTs) to synthesize a voltage generated by the VSC from a DC voltage source.
- The GTO (gate-turn-off thyristor) is used for higher voltage application while IGBT (integrated gate bipolar transistor) for lower voltage.
STATIC SYNCHRONOUS COMPENSATOR (STATCOM)

V-I characteristic of STATCOM and SVC
STATIC SYNCHRONOUS COMPENSATOR (STATCOM)

• STATCOM offer better voltage support and improved transient stability margin by providing more VARs at lower voltages.

• This is because the maximum capacitive power generated by a SVC is proportional to the square of the system voltage (constant susceptance) while the maximum capacitive power generated by a STATCOM decreases linearly with voltage (constant current).
• Since no large capacitors or reactors are used to generate VARs, STATCOM provides very fast response (no delay associate with thyristor firing) and greater stability to variations in system impedance.

• Harmonic elimination by selective firing of the GTOs means that STATCOM has further advantages over the SVC and can be used as an active filter.
Conclusion..

- Power quality is a well-defined field with growing interest being shown in the solution to the problems, monitoring equipment, regulations and statistical analysis of customers’ expected levels of disturbance.
Conclusion..

As future development grow widely, the new materials and devices become available where it may be possible to provide solutions for the cause of the power quality problem rather than treat the symptoms.