Introduction to Power Quality and EMC

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INTRODUCTION

At a time when the quantity of power and its cost have become more of a concern than ever for energy users, concerns about quality have made power decisions increasingly difficult. Power quality problems are costly. When poor power quality damages equipment, subsequent downtime for repair or replacement costs will reduce productivity, increase overhead, and lead to loss of customer confidence. This will cause reduction in sales.

Power quality problems are not limited to sensitive electronic components, either. Harmonic distortion, for instance, may also affect motors and transformers, and may make the entire system vulnerable to damage.

The proliferation of ever-more-sensitive electronic equipment in applications from office buildings to the factory floor has brought the issue of power quality to the forefront. As more and more sophisticated electronics are used in equipment for protection, detection and measurement, they have become more vulnerable to power anomalies. Power system events such as surge, lightning strike, or a problem with a piece of equipment that had little or no effect on the day-to-day business a few years back, may now have serious consequences.

DEFINING POWER QUALITY AND RELIABILITY

Power Quality and reliability have many different definitions, and they are often confused by end users. Electric utilities have specific definitions and indices for measuring reliability, but many customers consider any event that disrupts their processes as a reliability problem. It is important to understand the terminology and different components of the quality and reliability of the electric service.

RELIABILITY

The term reliability is used to indicate the ability of a system to continue to perform its intended function. Power-system reliability is measured in terms of the ability of the power system to provide electricity to end users. It is usually measured at the service to the end users, and tracked by average frequency and duration indices that are reported to the Energy Commission (EC) of Malaysia.

Figure 1: Sensitive electronic equipment

Outages or sustained interruptions are typically defined as a condition without supply lasting more than 1 minute, and momentary problems, such as voltage sags, are not considered in reliability indices. However, these shorter events can affect the reliability of end users.

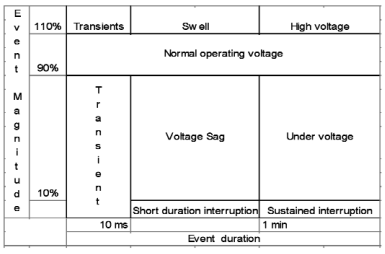

Figure 2: Definition of reliability and power quality disturbances (IEEE 1159)

POWER QUALITY (PQ)

While reliability measures the availability of supply of electricity to end users, Power Quality measures a wide range of power-supply characteristics that also can influence the performance of equipment and processes. In other words, the reliability of end-use processes is dependent on both the reliability and quality of the electric service.

Most users would associate an ideal sine wave with good electric power supply, which is what they want all the time. Unfortunately, multiple exposures of electric power system both inside and outside of the facility to transient, short, and long term events affects power quality.

The definition of Power Quality characteristics can be found in MS IEC Standard 61000-2-2 and MS IEC 61000-2-4 and in IEEE Standard 1159. The characteristics fall into two major categories: steady-state PQ variations and disturbances.

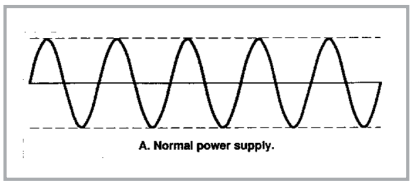

Figure 3: Ideal Sine Wave

Common power quality disturbances include surges, spikes and sags in electric power source voltage and harmonics (or "noise") on the power line. Each of these occurrences is discussed briefly below.

Surge – A rapid short-term increase in voltage. Surges often are caused when high power demand devices such as air conditioners turn off and the extra voltage is dissipated through the power line. Since sensitive electronic devices require a constant voltage, surges stress delicate components and cause premature failure.

Spike – An extremely high and nearly instantaneous increase in voltage with a very short duration measured in microseconds. Spikes are often caused by lightning or by events such as power coming back on after an outage. A spike can damage or destroy sensitive electronic equipment. Turn the equipment off during a power outage. Wait a few minutes after power is restored before turning it on, and then turn on one device at a time.

Sag – A rapid short-term decrease in voltage. Sag typically is caused by simultaneous high power demand of many electrical devices such as motors,

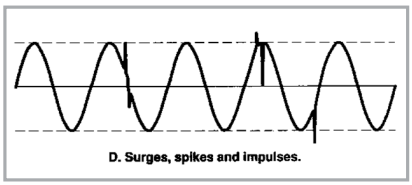

Figure 4: Surges and Spikes

compressors and so on. The effect of sag is to "starve" electronic equipment of electric power causing unexpected crashes and lost or corrupted data. Sags also reduce the efficiency and life span of electrical and electronic equipment such as PLCs and electric motors.

Noise – A disturbance in the smooth flow of electricity. Often technically referred to as electro-magnetic interference (EMI) or radio frequency interference (RFI). "Harmonics" are a special category of power line noise that causes distortions in electrical voltage. Noise can be caused by motors and electronic devices in the immediate vicinity or far away. Noise can affect performance of some equipment and introduce glitches and errors into software programs and data files.

Outage – Total loss of power for some period of time. Outages are caused by excessive demands on the power system, lightning strikes and accidental damage to power lines. In addition to shutting down all types of electrical equipment, outages cause unexpected data loss.

IMPACT OF POWER QUALITY

While power disturbances occur on all electrical systems, the sensitivity of today's electronics makes them more susceptible to them. For some sensitive devices, a momentary disturbance can cause scrambled data, interrupted communications, a frozen mouse, system crashes and equipment failure. A power voltage spike can damage valuable components. Power quality issues can cause business problems such as:

- Lost productivity and idle people and equipment
- Lost orders, good will, customers and profits
- Lost transactions and orders not being processed
- Revenue and accounting problems such as invoices not prepared, payments held up, and early payment discounts missed Customerand/or management dissatisfaction
- Overtime required to make up for lost work time

ASSESS YOUR POWER QUALITY NEEDS

While it is best to have a detailed assessment of your risk of problems from power quality disturbances conducted by a trained power quality professional, you can take the first step by completing the self-assessment included below.

1. Does your business have electronic equipment that is especially sensitive to power quality disturbances (power surges, outages, etc.) including drives, computers, cash registers, laser printers telephone exchange/switches, fax machines, copiers, and medical equipment?

2. Is your building or facility more than 10 years old? Older facilities were not designed to handle the electrical demands of today's business equipment. Because up to 80 percent of power quality disturbances originate inside a facility, these older facilities tend to experience more problems.

3. Do you have electronic equipment that operates 24 hours a day? Lightning storms in the Klang Valley area tend to occur most frequently between 6:00 p.m.-9:00 p.m. Lightning strikes are responsible for more than 20 % of outages and other power quality disturbances.

4. Do you have a modem line or coaxial cable entering your facility? These lines can introduce "back-door" power disturbances into your facility.

5. Does your business have more than five users on a computer network system? The larger a computer network grows, the more susceptible a system becomes to power disturbances.

6. Have you experienced any power outages or other disturbances in the past two years? Past experience is a good indicator that you are at risk for future problems.

7. Does your facility lack adequateprotection against power quality disturbances? Adequate protection includes service entrance protection, modem/coaxial and telephone line protection, and point-of-use surgesuppressers and uninterruptible power supplies for critical equipment.

If you answered "yes" to three or more of the questions above, your business has a higher risk of experiencing power quality problems.

ELECTROMAGNETIC COMPATIBILITY (EMC)

Electromagnetic compatibility itself is defined as: "the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment."

Compatibility levels for these power quality characteristics should be identified. These compatibility levels are designed such that end-user equipment will operate properly and optimal for the system. Most of these power quality characteristics require close coordination between the operation of end-user facilities and the performance of the electric power system.

MS and IEC Standards have defined compatibility levels for these characteristics, and these compatibility levels are the basis of actual requirements for the power-system performance in Europe (EN 50160).

Some equipment manufacturers are doing a better job of describing equipment performance when subjected to electric power-supply variations. The ITI curve, developed by the Information Technology Industry Council, defines the expected performance of PCs, printers and monitors. This concept was taken up by the semiconductor industry, in cooperation with utilities, and a new standard for semiconductor production equipment was developed that will result in more reliable performance for typical power systems. The SEMI F47 ride-through curve specifies that these tools should ride through sags with a minimum voltage as low as 50% that last up to 200 msec.

The new MS IEC 61000-4-11 is a mirror image of SEMI F47 but advocates robustness in voltage sag immunity requirement. Sensitive equipment should ride through sags with a minimum voltage as low as 0% and 40 % that last up to 20 msec and 200 msec.

POWER QUALITY SOLUTIONS

Power Quality disturbances can also affect the operation of end-user equipment and process.

These include transient voltages, voltage sags, harmonics and momentary interruptions.

Power Quality solutions generally fall into either or both of these categories:

- Upgrading facility wiring and grounding systems, and/or
- Installing mitigation equipments such as Filters, UPS, Dip Proofing Inverter etc.

The alternative to adding these mitigating devices to the production equipment is to purchase and develop equipment designed to tolerate power quality events. This proactive approach takes more planning, but results in lower overall system costs. ■

REFERENCES

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[3] Transmission and Distribution World 2004