

THE EXPANDING PROBLEM OF HIGH FREQUENCY NOISE

More and more, our everyday environments are becoming electronic equipment centers. Whether in an office, school, automated manufacturing facility, hospital or our own home, electronic devices are increasingly finding their way into our daily lives. Also increasing is our dependence upon them. How often do you depend on your computer, telecommunications network, fax machine or copier at work? How much actual work can you accomplish without them?

ELECTRONICS: THEY'RE EVERYWHERE

Today, electronic equipment abounds. Personal computers can be found at almost every workstation in any given office building. The single daisy-wheel printer has been replaced by multiple laser units, most often at a reduced cost and with a gain in performance. The same holds true for photocopiers and fax machines. Health professionals now use microprocessor-based equipment to perform a multitude of functions, from filling cavities to critical medical processing tasks such as MRI and CT scans. The modern factory floor abounds with robotic welders and automated manufacturing and quality assurance equipment. Even in our homes we find electronic components in alarm clocks, coffeemakers, VCRs and televisions and personal computers. Electrically driven or electronically powered products are everywhere, and they're here to stay.

The general trend in the electronic industry is to continue developing microprocessors that operate faster, consume less power and occupy less space. As products get smaller while providing more output with less electrical power, their susceptibility to poor power quality will increase. Electrical high frequency noise that would have gone unnoticed in larger, slower devices now has the capability to cause damage and downtime. These electrical disturbances aren't going to go away, but steps can be taken to prevent transient episodes or cumulative events from wreaking havoc in today's busy world.

IDENTIFYING UPSET

In the following paragraph, ANSI/IEEE C62.41.1-2002 discusses a phenomenon called "system upset" with respect to low level, high speed power line signals that can interfere with sensitive electronics:

Upset: This consequence can be a self recoverable upset by design of the software and therefore not immediately apparent, or may be a permanent upset requiring operator intervention or programmed automatic action occurring after some time delay. Many documents on test methods suggest three classes for this type of consequence as follows:

- (a) Minor: acceptable temporary loss of function, but no faulty operation
- (b) Major: temporary faulty operation or performance (which is self recoverable)
- (c) Critical: faulty operation or performance that requires operator intervention or system reset

It should be noted that this system upset is caused by high speed, lower magnitude power signals. These signals may be high frequency noise or lower level transients beneath a surge suppressor's clamping voltage level.

The ANSI/IEEE C62.41 description above sheds revealing light on conducted electrical noise problems. For the purpose of this manuscript, conducted high frequency noise will be defined as follows:

Conducted high frequency noise is any signal of greater than 1000 times the fundamental power frequency (60Hz) with a magnitude of less than twice the RMS voltage of the distribution system. This definition includes low level impulses.

Interference with digital processing occurs when high frequency noise is conducted or coupled into digital systems. The result is seen by the user as system upset. Figure 1 illustrates a typical digital square wave data signal from a 10-year-old personal computer operating at 4.77mhz. A noise signal is intermingled with the data. Because of their higher data signal voltages, the less-sensitive electronics of a decade ago would not have interpreted this noise as an upsetting signal. Why? Because the digital circuitry was not as sensitive or as fast as it is on today's digital systems.

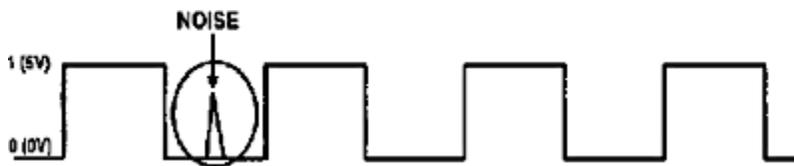


Figure 1. High Frequency Noise From, 4.77MHz, 5 Volt



Figure 2. High Frequency Noise From, 50MHz, 3.3 Volt

Using the same scale as Figure 1, Figure 2 shows a typical digital signal for a recently manufactured 486-microprocessor used in a personal computer operating at 50mhz. Once again, a noise signal is also intermingled with the data. The same signal which caused no disturbance in the older personal computer now changes one of the digital "zeros" in the newer, faster device to a digital "one," thereby corrupting data.

Consider the ramifications of this occurrence. If the data signal is an instruction to the digital circuit, a different instruction will now be read. If the digital circuitry is part of a factory automation system, the uncorrupted signal may indicate that a part has been approved during automated testing. Because the corrupted data has been misinterpreted, rejection rather than acceptance of the part has actually occurred. In worst-case scenarios, the corrupted and meaningless data will cause the circuit to lock up or enter an undefined state.

As microprocessors continue to increase in speed and chip voltage potentials decrease, these problems will only escalate. A couple of volts of high speed noise will be all that is required to change the process of the system.

WHAT CAUSES INTERNAL NOISE DISTURBANCES?

A multitude of situations can lead to high frequency noise upset episodes, but one often-overlooked source of internal disturbances is the electrical distribution system within an older facility. Designed decades ago to power electric typewriters, pencil sharpeners and desktop light fixtures, this same system is now serving computer networks, an HVAC system and other microprocessor-based electronic equipment. Although technically still in compliance with National Electric Code standards, these dated electrical distribution systems are ill-equipped to satisfy today's demanding loads and can most likely be classified as "code minimum."