Power Quality Measurement Equipment V

Spectrum analyzers and harmonic analyzers

Instruments in the disturbance analyzer category have very limited harmonic analysis capabilities. Some of the more powerful analyzers have add-on modules that can be used for computing fast Fourier transform (FFT) calculations to determine the lower-order harmonics.

However, any significant harmonic measurement requirements will demand an instrument that is designed for spectral analysis or harmonic analysis. Important capabilities for useful harmonic measurements include

- ❷ Capability to measure both voltage and current simultaneously so that harmonic power flow information can be obtained.
- ❷ Capability to measure both magnitude and phase angle of individual harmonic components (also needed for power flow calculations).
- ❷ Synchronization and a sampling rate fast enough to obtain accurate measurement of harmonic components up to at least the 37th harmonic (this requirement is a combination of a high sampling rate and a sampling interval based on the 60-Hz fundamental).

- Capability to characterize the statistical nature of harmonic distortion levels (harmonics levels change with changing load conditions and changing system conditions).

There are basically three categories of instruments to consider for harmonic analysis:

Simple meters.

It may sometimes be necessary to make a quick check of harmonic levels at a problem location. A simple, portable meter for this purpose is ideal. There are now several hand-held instruments of this type on the market. Each instrument has advantages and disadvantages in its operation and design. These devices generally use microprocessor-based circuitry to perform the necessary calculations to determine individual harmonics up to the 50^{th} harmonic, as well as the rms, the THD, and the telephone influence factor (TIF). Some of these devices can calculate harmonic powers (magnitudes and angles) and can upload stored waveforms and calculated data to a personal computer.

General-purpose spectrum analyzers

Instruments in this category are designed to perform spectrum analysis on waveforms for a wide variety of applications. They are general signal analysis instruments. The advantage of these instruments is that they have very powerful capabilities for a reasonable price since they are designed for a broader market than just power system applications. The disadvantage is that they are not designed specifically for sampling power frequency waveforms and, therefore, must be used carefully to assure accurate harmonic analysis. There are a wide variety of instruments in this category.

Special-purpose power system harmonic analyzers.

Besides the general-purpose spectrum analyzers just described, there are also a number of instruments and devices that have been designed specifically for power system harmonic analysis. These are based on the FFT with sampling rates specifically designed for determining harmonic components in power signals. They can generally be left in the field and include communications capability for remote monitoring.

5.3.10 Combination disturbance and harmonic analyzers

The most recent instruments combine harmonic sampling and energy monitoring functions with complete disturbance monitoring functions as well. The output is graphically based, and the data are remotely gathered over phone lines into a central database. Statistical analysis

can then be performed on the data. The data are also available for input and manipulation into other programs such as spreadsheets and other graphical output processors.

One example of such an instrument is shown in Fig. 5.11. This instrument is designed for both utility and end-user applications, being mounted in a suitable enclosure for installation outdoors on utility poles. It monitors three-phase voltages and currents (plus neutrals) simultaneously, which is very important for diagnosing power quality problems. The instrument captures the raw data and saves the data in internal storage for remote downloading. Off-line analysis is performed with powerful software that can produce a variety of outputs. The top chart shows a typical result for voltage sag. Both the rms variation for the first 0.8 s and the actual waveform for the first 175 ms are shown. The middle chart shows a typical wave fault capture from a capacitor-switching operation. The bottomchart demonstrates the capability to report harmonics of a distorted waveform. Both the actual waveform and the harmonic spectrum can be obtained.

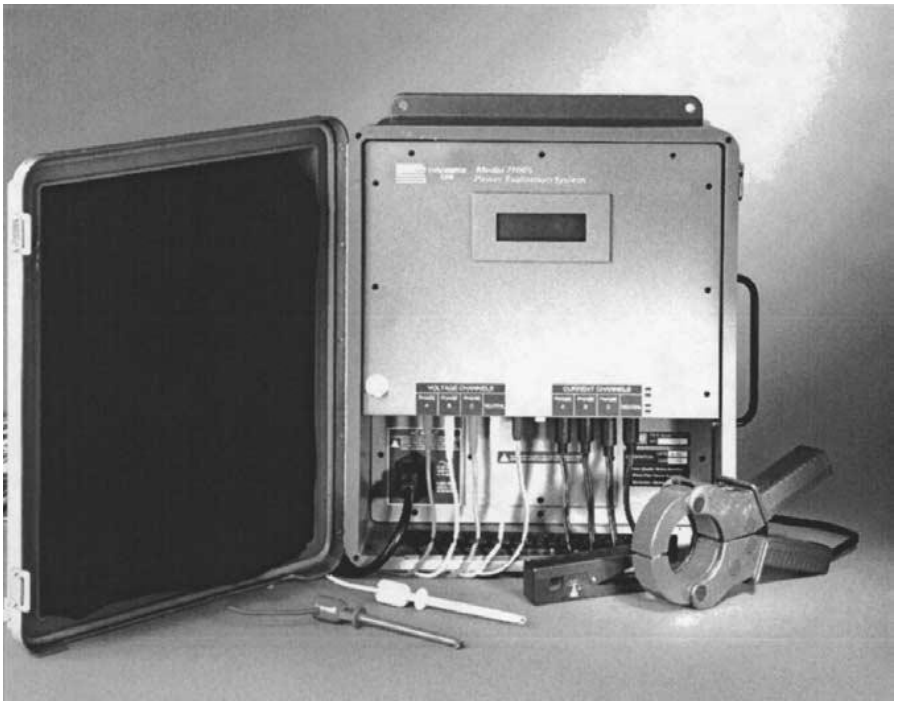

Figure 5.11 A power quality monitoring instrument capable of monitoring disturbances, harmonics, and other steady-state phenomena on both utility systems and end-user systems.

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