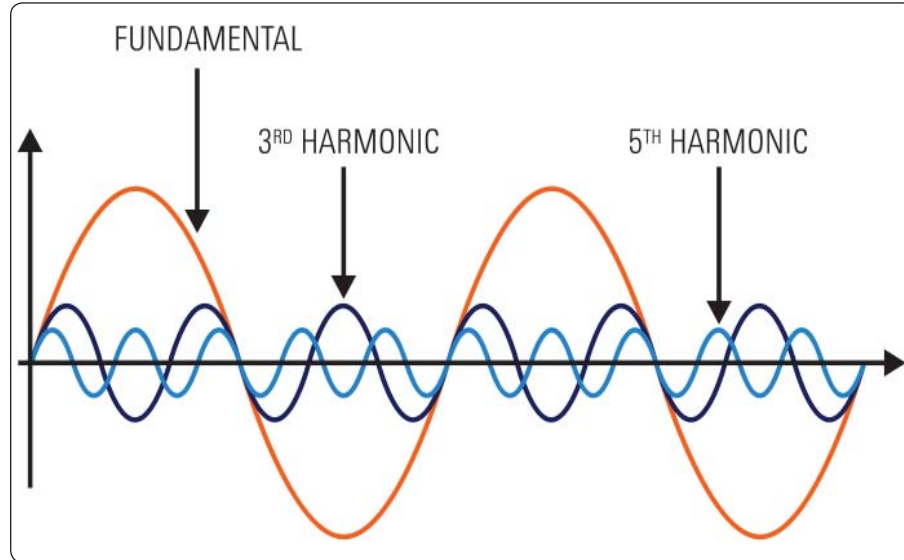


**Agilent**

## Detecting Harmonics in AC Signals

Application Note



## Introduction

Ideally, the voltage and current (AC power) waveforms are perfect and purely sinusoidal. In real life, this is impossible because there are too many electronic devices powered by switched-mode current pulses create significant distortion in the electrical current and voltage wave shape. The distortion travels back into the power source and can affect other equipment connected to the same source. Much of the distortion shows up in the form of harmonics. In this application note, we will discuss some of the problems related to harmonics and a tool available to detect them before catastrophic events occur.



Figure 1: Unwanted harmonics can cause catastrophic problems for electrical-distribution system.

## Problems

Here are some of the problems that can occur if harmonics are present in an electrical distribution system:

### **Large load currents in the neutral wires of three-phase system**

The neutral current can be the sum of all three phases and therefore cause overheating of the neutral wires. Because only the phase wires are protected by circuit breakers or fuses, this can result in a potential fire hazard.

### **Dangerous overheating of standard electrical supply transformers**

Overheating can shorten the life span of a transformer and will eventually destroy it. When a transformer fails, the cost of lost productivity during the emergency repair can be far exceed the replacement cost of the transformer itself.

### **False tripping of branch circuit breakers**

Higher frequencies that harmonics produce cause peak-sensing circuit breakers to trip even though the amperage value has not been exceeded. The harmonic current peak values produced can be many times higher than sinusoidal waveforms.

### **Blowing of fuses and damage the surge suppressors**

Resonance produces over-current surges. This destroys capacitors, fuses and damages surge suppressors, causing the electrical system to shut down.

### **Vibrating bus bars and electrical panels**

Electrical panels are designed to carry 60 Hz current, which then becomes mechanically resonant to the magnetic fields generated by higher-frequency harmonic current. Under these conditions, the panel can vibrate and emit an audible buzzing sound at the harmonic frequency.

## Solution

In the past, users may have needed an expensive instrument such as an oscilloscope or spectrum analyzer to detect and measure the presence of harmonics. Now, the Agilent U1242A handheld digital multimeter offers the HARMONIC RATIO function to measure it cost effectively.

The Harmonic Ration function calculates a value from 0% to 100% to indicate the deviation of non-sinusoidal and sinusoidal waveform, which indicates the presence of harmonics. Below is the equation for the Harmonic Ratio:

$$\text{Harmonic Ratio (\%)} = [(V_{\text{rms}} - V_{\text{avg}}) / V_{\text{rms}}] \times 100\%$$

A pure sinusoidal waveform without harmonics has a Harmonic Ratio of 0%. Measurements with higher Harmonic Ratio show that more harmonics are present in the signal. The table below shows some examples of accuracy for various waveforms for the True RMS and Average Responding DMM, and the Harmonic Ratio reading.

Waveform	True RMS	Average Responding	Harmonic Ratio
Pure sine wave	Accurate	Accurate	0%
Square wave	Accurate	10% high	- 10%
One-phase diode rectifier	Accurate	40% low	40%
Three-phase diode rectifier	Accurate	5 ~ 30% low	5 ~ 30%
Sawtooth	Accurate	13.3% high	- 13.3%

Table 1: Measurement accuracy between True RMS and Average Responding DMM, and harmonic ratio for typical waveforms.

## Conclusion

With the built-in Harmonic Ratio function, the Agilent U1242A handheld DMM helps technicians and engineers quickly verify the presence of harmonics in AC signals. This reduces equipment downtime and repair costs.



Figure 2: The Agilent U1242A handheld DMM has a built-in Harmonic Ratio function to detect the presence of harmonics with a push of a button.



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