FLUKE®

The vibrating transformer

Application Note

Power Quality **Case Study**

Measuring tools: Fluke 43B Power Quality Analyzer

Operator: Electrical contractor's engineer

Features used: Current, harmonic spectrum, THD

Problem description

This case history comes from an electrical contractor. Several of this contractor's clients operate large commercial buildings. One of these clients asked for help with a large transformer that had suddenly started vibrating and making a loud buzzing sound. The client was concerned that the transformer was ready to fail and he would be faced with an expensive replacement. The contractor dispatched an engineer at once.

When the engineer arrived at the plant, he took out his notebook and his Fluke 43B. He then made the following notes and one line diagram:

Transformer size: 1500 kVA

Transformer configuration: Delta/wye, 480 V 3-phase secondary

Secondary load: Motors, lighting, and office machines for a large office building

Note: The client says the transformer is lightly loaded because many of the tenants have recently moved to a new location.

Measurement data

The engineer recorded the following data using the Fluke 43B:

Secondary voltage total harmonic distortion: 2.7 %

Secondary voltage balance: within 1 %

Secondary current: 57 A rms

Secondary current spectrum:
Fundamental 55 A
2nd harmonic 1.6 A
3rd harmonic 2.5 A
4th harmonic 0.7 A
5th harmonic 2.4 A
6th harmonic 0.4 A
7th harmonic 4.0 A

Theory and analysis

The voltage measurements do not show anything abnormal. The voltage total harmonic distortion is well within the maximum allowable value of 5 %. Voltage balance between phases also looks good. The secondary current of 57 A indicates the client was correct in stating the transformer was lightly loaded. No overheating was noted.

When a transformer is in trouble, this contractor's engineers always use a Fluke 43B to measure the harmonic spectrum of the

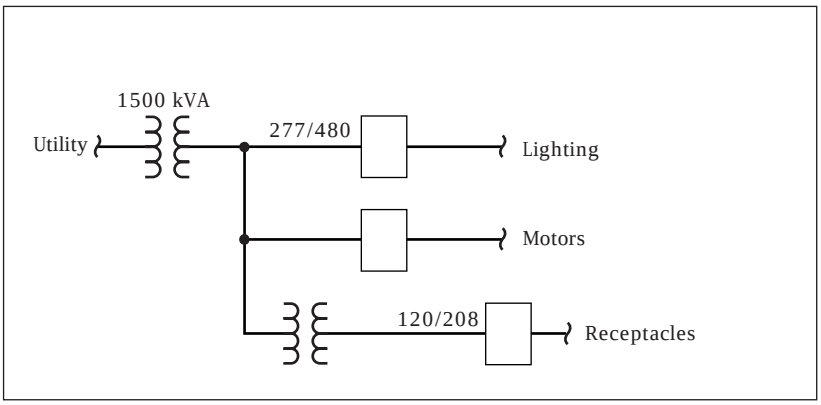

Fig. 1 Partial one-line diagram of large commercial building

secondary current. The spectrum acts like a fingerprint, indicating the types of loads present. In this case, the presence of the 3rd harmonic shows that part of the load consists of single-phase devices (e.g., fluorescent lighting ballasts) connected phase to neutral. In the data, the amount of the 3rd harmonic is relatively low and appears to be normal.

The 5th and 7th harmonics indicate that part of the load is a large 3-phase device with semiconductor rectifiers in the input circuit. The most common example would be an adjustable speed motor drive operating a fan or pump. When a 3-phase motor drive is operating normally, the input current waveforms are symmetrical about zero. That is, the positive going portion of the waveform looks like the mirror image of the negative portion. When all semiconductors are operating normally, the input currents have no dc offset and only odd harmonics are present.

The engineer noted that the spectrum had even harmonics (2nd, 4th, and 6th). These abnormal harmonics indicate the presence of dc current in the transformer secondary winding. Compare the example spectrums in Fig. 2 and Fig. 3. Unfortunately, dc current tends to saturate the transformer core at the peak of one half of the ac waveform. When the core goes in and out of saturation, it will vibrate and make a loud buzzing noise.

The engineer suspected that the plant load contained a large motor drive and that one of the input semiconductors had failed open. If one semiconductor is open, the circuit on that phase becomes a half-wave rectifier — it produces dc current. The trick here is that the motor drive will continue to operate at low speed because the other two phases are operating normally.

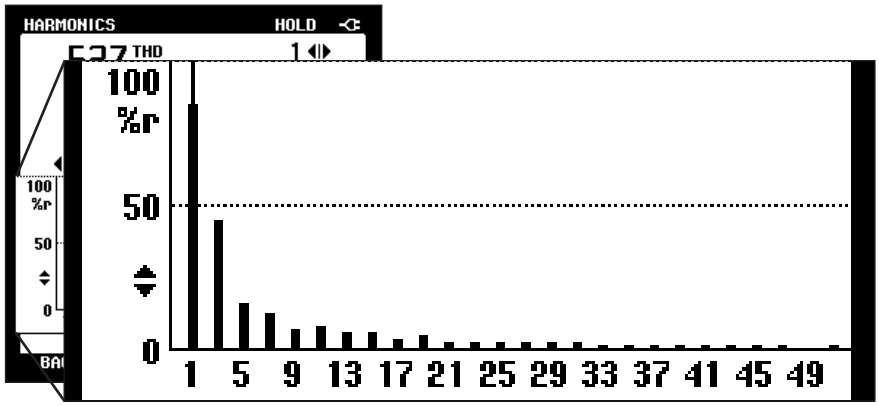

Fig. 2 Example of a normal ac current spectrum with all odd harmonics

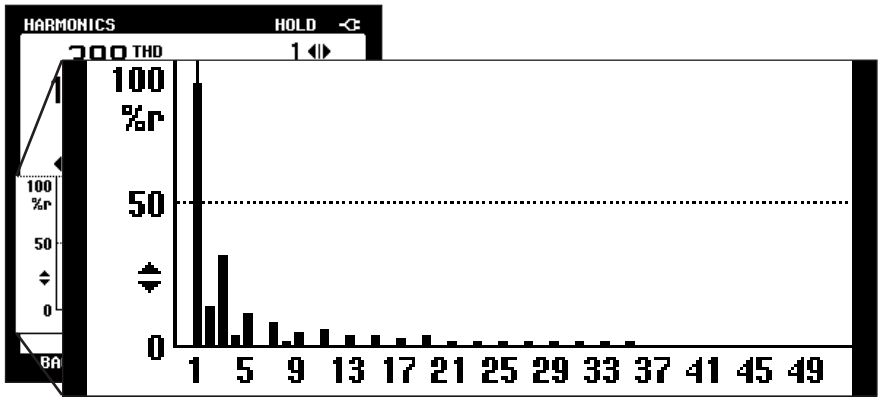

Fig. 3 Example of an abnormal current spectrum with both odd and even harmonics

Solution

The engineer asked if any large motor drives were operating. The plant manager confirmed that one large drive was operating a ventilation fan. The engineer instructed the plant manager to have the drive shut off. When the drive was shut off, the transformer immediately stopped vibrating.

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Fluke Corporation
PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa (31 40) 2 675 200 or
Fax (31 40) 2 675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
Web access: http://www.fluke.com/

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