FLUKE®

Half wave rectifier

Application Note

Power Quality **Case Study**

Measuring tools: Fluke 43B Power Quality Analyzer

Operator: School district electrician

Features used: KVA measurements, current waveform

Problem description

This case history involves an electrician who works for a large suburban school district. One winter morning, the electrician received a call from a local school. The caller said a transformer supplying power to three portable classrooms was making a “chattering” noise, as if something were loose inside (see Fig. 1).

Load measurements showed the transformer was heavily loaded, but not overloaded. The loads included lights, electric heat, and a few computers. Most of the load was electric heat, due to cold winter weather.

Because the electrician had arrived near lunchtime and the school had a staggered lunch schedule, two of the classrooms were unoccupied. A third classroom was occupied and the teacher was making a presentation with overhead slides.

The electrician returned to the transformer to examine the current waveforms. As he was making measurements, the chattering noise suddenly stopped. The electrician rushed back to the occupied classroom and asked the teacher, “What did you just now turn off?” The teacher pointed to two overhead projectors, which were plugged into the same receptacle.

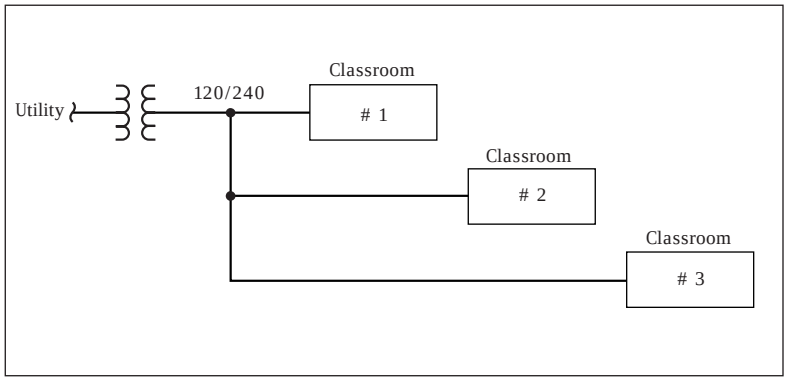

Fig. 1 One-line diagram of the school transformer

Measurements

The electrician connected his current clamp and Fluke 43B to one of the conductors of a split extension cord. Then, he displayed the waveform of current drawn by one of the overhead projectors. The waveform showed half-wave rectification by the projector (see Fig. 2). Fig. 3 is the harmonic spectrum.

Testing of other overhead projectors used at the school showed that all of the older units produced the same effect, but the newer units did not.

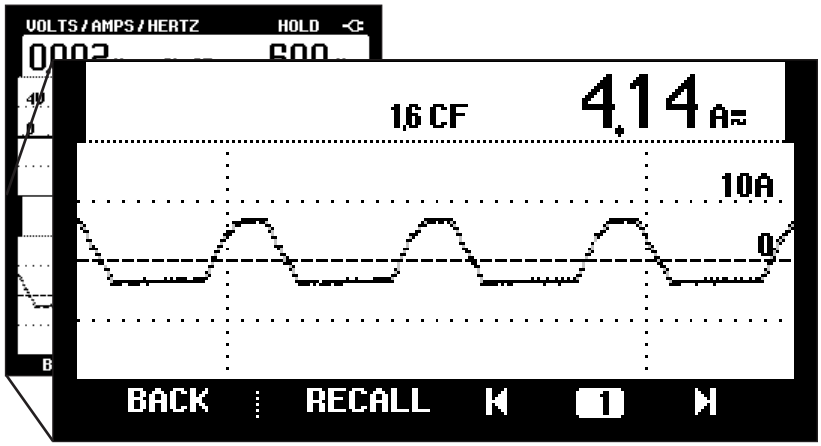

Fig. 2 Overhead projector line current waveform

Theory and analysis

Some older electrical devices use half wave rectifiers to reduce power consumption. An example would be an early hair dryer with a “high/low” switch. At low speed, a series diode allows the circuit to draw current on only half of the voltage cycle. At high speed, the switch shorts out the diode — to allow current to flow during the full cycle. These devices wreak havoc on ac power distribution systems, because they generate dc current in the half wave configuration. The dc current will unbalance the magnetic flux in the transformer and push the transformer core into saturation on one half of the current cycle. The process of going in and out of saturation will produce strange noises from the transformer core. The school’s transformer was heavily loaded, which reduced its tolerance for dc current. Compounding the problem, two projectors were connected to the same branch circuit — thereby doubling the amount of dc current.

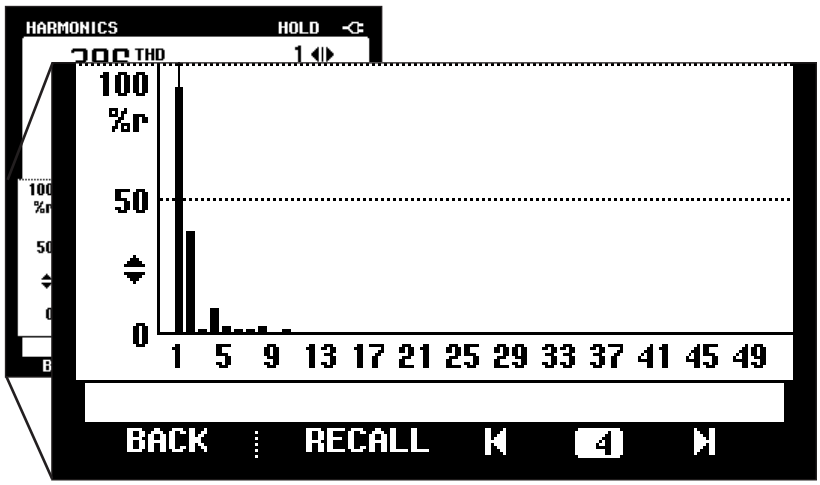

Fig. 3 Overhead projector current harmonic spectrum showing high 2nd harmonic

Solution

The electrician considered connecting the projectors on opposite phases so that the dc currents would cancel. But, this would likely prove to be too confusing for the teachers. The real cure was to use only the new overhead projectors that did not have the half wave rectifier circuits.

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Printed in U.S.A. 8/2003 2103547 A-ENG-N Rev A