FLUKE®

Overheated transformer

Application Note

Power Quality **Case Study**

Measuring tools: Fluke 434 Power Quality Analyzer

Features: Scope, Power & Energy, Harmonics

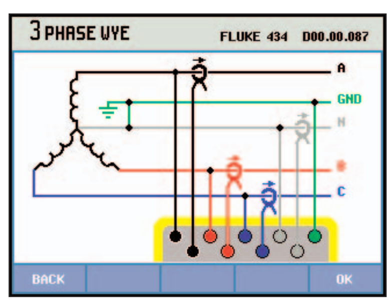
Problem description

You could almost call it a happy accident. During a routine job at a large industrial facility, an electrical maintenance worker set a plastic kit on top of a nearby transformer. By the time he reached back for it a few minutes later, it had started to melt! Obviously, the transformer was operating well over its normal temperature range.

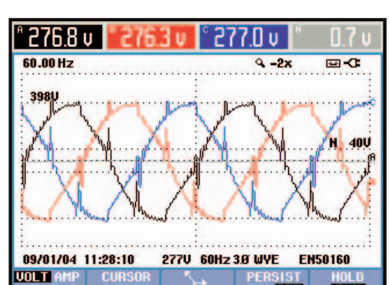
The technician took a few readings with his DMM, but the numerical rms readout didn't reveal the problem. Suspecting the transformer was over-loaded, he went to the equipment cage and brought back the team's three-phase power quality analyzer to calculate the apparent power (kVA) and see what the scope tool revealed.

Measurements

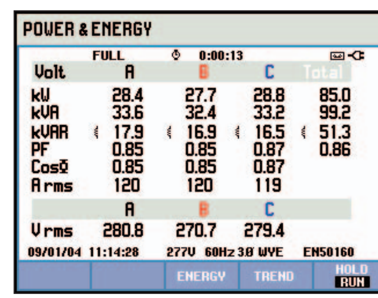
To verify the accuracy of his connections, the technician checked the View Config screen on the power quality analyzer. The one-line diagram matched up.



As a starting point, the tech-nician pushed the Scope button, to check for distortion. The waveform signatures were in fact suspiciously distorted.



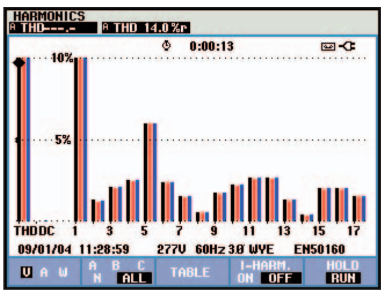
Next, he selected Power & Energy from the menu and compared the kVA calculated by the analyzer to the transformer nameplate's kVA. Sure enough, this transformer was heavily loaded (> 50 %). That meant harmonics were also a concern.

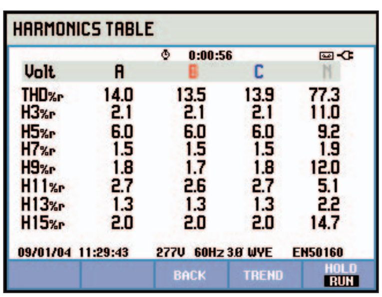


Power

Harmonics originate from loads that generate non-linear currents, such as adjustable speed drives, DC-powered equipment and even computers and office equipment. When these harmonic currents travel through the system impedance, they distort voltage sinewaves. The voltage distortion then spreads the harmonic pollution throughout the system.

The technician selected the Harmonics function from the power quality analyzer menu and reviewed the Total Harmonic Distortion (THD) bar-graph. THD measures the combined action of all the harmonics (on multiple frequencies) present, compared to the overall system. THD should not exceed 5 %.




HARMONICS TABLE

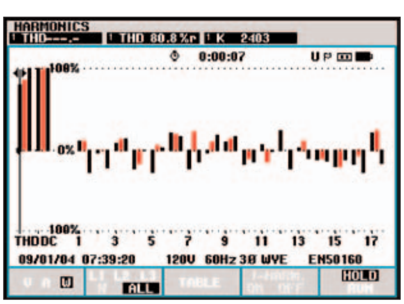
0:00:56

Volt	A	B	C	N
THD%r	14.0	13.5	13.9	77.3
H3%r	2.1	2.1	2.1	11.0
H5%r	6.0	6.0	6.0	9.2
H7%r	1.5	1.5	1.5	1.9
H9%r	1.8	1.7	1.8	12.0
H11%r	2.7	2.6	2.7	5.1
H13%r	1.3	1.3	1.3	2.2
H15%r	2.0	2.0	2.0	14.7

09/01/04 11:29:43 277V 60Hz 3Ø WYE EN50160

BACK TREND HOLD RUN

At an average of 13.8 % across all phases, this THD reading was way too high. He selected the Watts reading (W) to get an idea of what the K factor was for the transformer's derating.



K-factor measures the heating effects of harmonics on transformer loading and losses. K-1 is the baseline for a standard transformer. K-4 would be for times the "normal" heating. K-rated transformer are specifically designed to handle harmonics.

Derating is a way of calculating the realistic load a transformer can carry when harmonics are present. For example, while a transformer may be rated at 150 kVA, harmonics would derate it to a 75 kVA load availability.

The higher the harmonics the less efficient the transformer is and the less current it can carry — the harmonics are competing for the total rating. In this case, the combination of customer load and harmonics had resulted in an overloaded transformer.

So, were the harmonics too high or the transformer insufficient? The technician began tracing the load. THD and K-factor are worst-case at the load vs. elsewhere in the distribution system. This is because source impedance is highest at the load, and source impedance is what drives THD and K-factor higher.

He realized that while the plant floor had been updated to include a full assortment of harmonic-laden electrical and electronic technology, the entire electrical system was still designed to support the original, 75 year-old electrical load.

Conclusion

Based on the harmonic levels and loading figures gathered by power quality analyzer, the technician went to the floor manager and recommended a new K-rated transformer designed to support the real load for that production area.

In the meantime, he suggested either transferring some of the current load to other transformers or staggering the timing of the loads. He also recommended regular harmonics and system impedance measurements. The new transformer wouldn't overheat, but given the amount of harmonics on this system they would have to consistently track THD throughout the floor.

Fluke. *Keeping your world up and running.*

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Printed in U.S.A. 12/2004 2398543 A-ENG-N Rev A