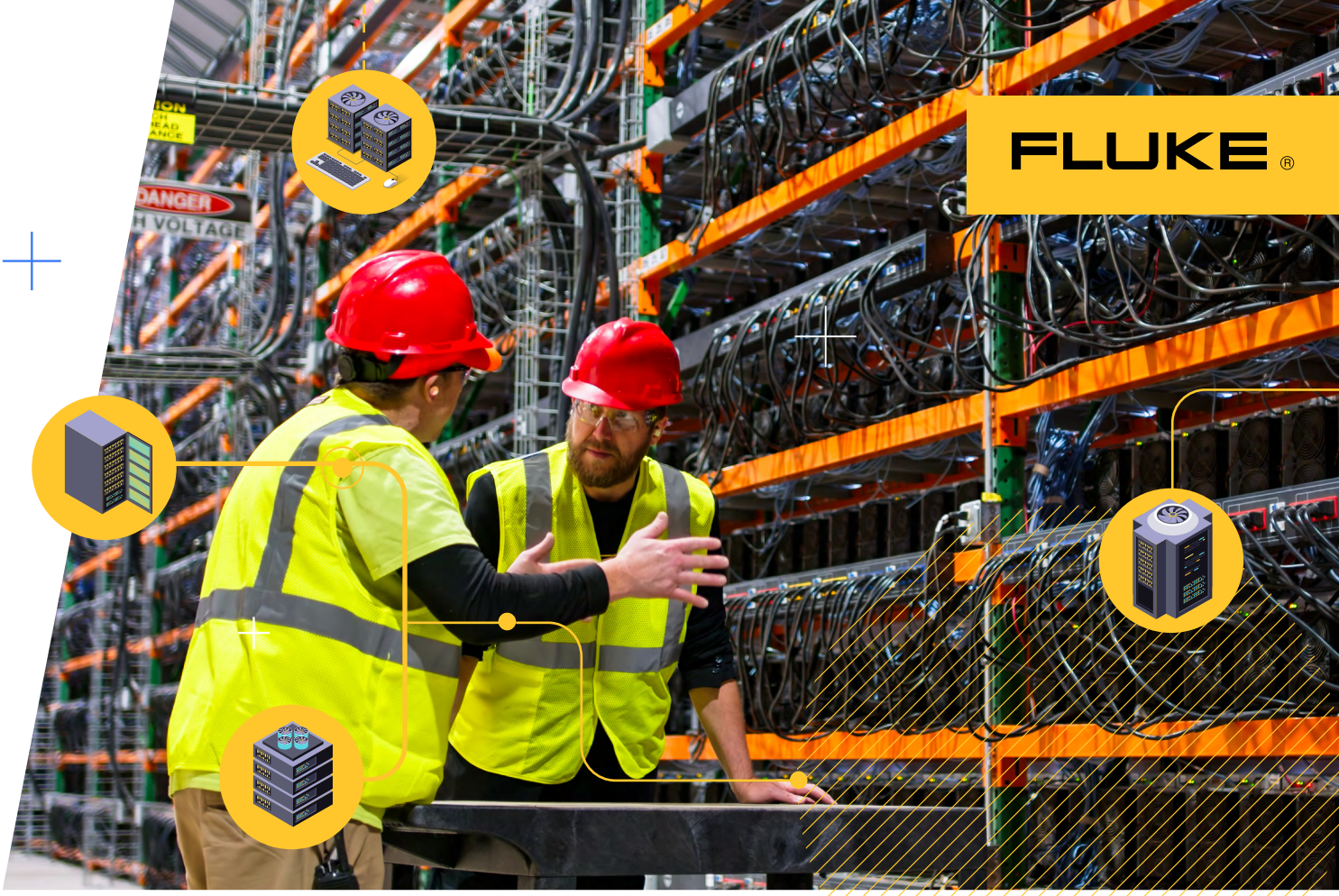

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How to troubleshoot **harmonic distortion in data centers**

BY JASON AXELSON,
FLUKE SUBJECT MATTER EXPERT, POWER QUALITY

Harmonics in data centers are a silent problem. They chip away at capacity, increase utility costs, and threaten uptime, often without any obvious warning signs.

Sometimes the symptoms surface through hot panels, tripped breakers, UPS issues, or buzzing sounds emitted by equipment. Other times, harmonics go undetected until a major disruption or equipment failure makes them impossible to ignore.

Diagnosing harmonics means identifying where the problem starts and intervening with corrective action to prevent energy loss, damage, or even downtime. Here's how to approach it.

Step 1: Confirm harmonic distortion is present

Harmonics can be present in a data center without causing immediate damage. The first task is to confirm whether total harmonic distortion (THD) exceeds the recommended limits. That means checking power distribution unit (PDU) and uninterruptible power supply (UPS) manufacturer recommendations to understand how each device recognises harmonics and at what THD level the UPS would trip or switch to battery backup, both of which shorten battery life and compromise uptime.

Acceptable limits vary depending on the equipment. Typically, recommended levels are 5% for voltage harmonics and 20% for current harmonics. IEEE 519-2022 thresholds are 8% for voltage and upwards of 20% for current, though these apply to the point of common coupling (PCC) between the facility and the utility transformer. The real questions are whether there's an active problem and how much voltage distortion is occurring under load.

Tools like the Fluke 1777 Three-Phase Power Quality Analyzer, which supports waveform capture, make this visible. They record events that fall outside defined thresholds, such as voltage dips and swells, giving teams the trend and waveshape data needed to make an informed call.

Step 2: Isolate the source of distortion

Once harmonics are confirmed, source tracing is the next step. The key question is whether the distortion is coming from upstream or downstream. A positive harmonic power reading on the analyser suggests an upstream source. A negative reading indicates the harmonics are load-induced, generated by equipment within the facility.

Common harmonic-inducing loads include energizing and saturating transformers, UPS systems, IT equipment such as servers and storage, variable frequency drives (VFDs), LED lighting systems, and inverters or power converters.

Understanding harmonic directionality requires the Fluke 1777. Other tools can identify harmonics, but they can't quantify direction or assist meaningfully with source identification.

Step 3: Apply the right remediation

There are several routes to fixing harmonic distortion. The right one depends on the source.

Load balancing

Load balancing reduces neutral current and the thermal stress on transformers, freeing up capacity and extending equipment lifespan.

Installing harmonic filters

Harmonic filters come in two types: active and passive. Passive filters target specific harmonic frequencies and are typically more cost-effective, but if improperly tuned, they can introduce resonance to the system, amplifying distortion rather than reducing it. Active filters automatically self-adjust to eliminate harmonic frequencies, though they can cost more.

Equipment replacement

High neutral currents during measurement can indicate transformer heating. Thermal imaging can confirm this, alongside comparisons to manufacturer specifications.

Where a transformer lacks an adequate K rating, replacing it with a K-13 or K-20 rated model mitigates harmonics. K-rated transformers are designed to handle harmonics without overheating. The Fluke 1777 can calculate transformer K-ratings where this is uncertain.

Reconfiguring loads or separating circuits

Redistributing harmonic-generating equipment or isolating it from sensitive loads minimises the impact of distortion on critical systems. Replacing older UPS systems with transformerless models can reduce harmonic generation at the source. In some cases, simply relocating sensitive equipment away from harmonic-heavy circuits resolves performance issues without requiring major system changes.

Zig-zag transformers

Zig-zag transformers provide a low-impedance path for zero-sequence currents, helping to cancel out triplen harmonics, particularly the problematic third harmonic, on the neutral, preventing overloaded neutral conductors, and reducing the associated heating in systems with heavy nonlinear loads.

Phase shifting

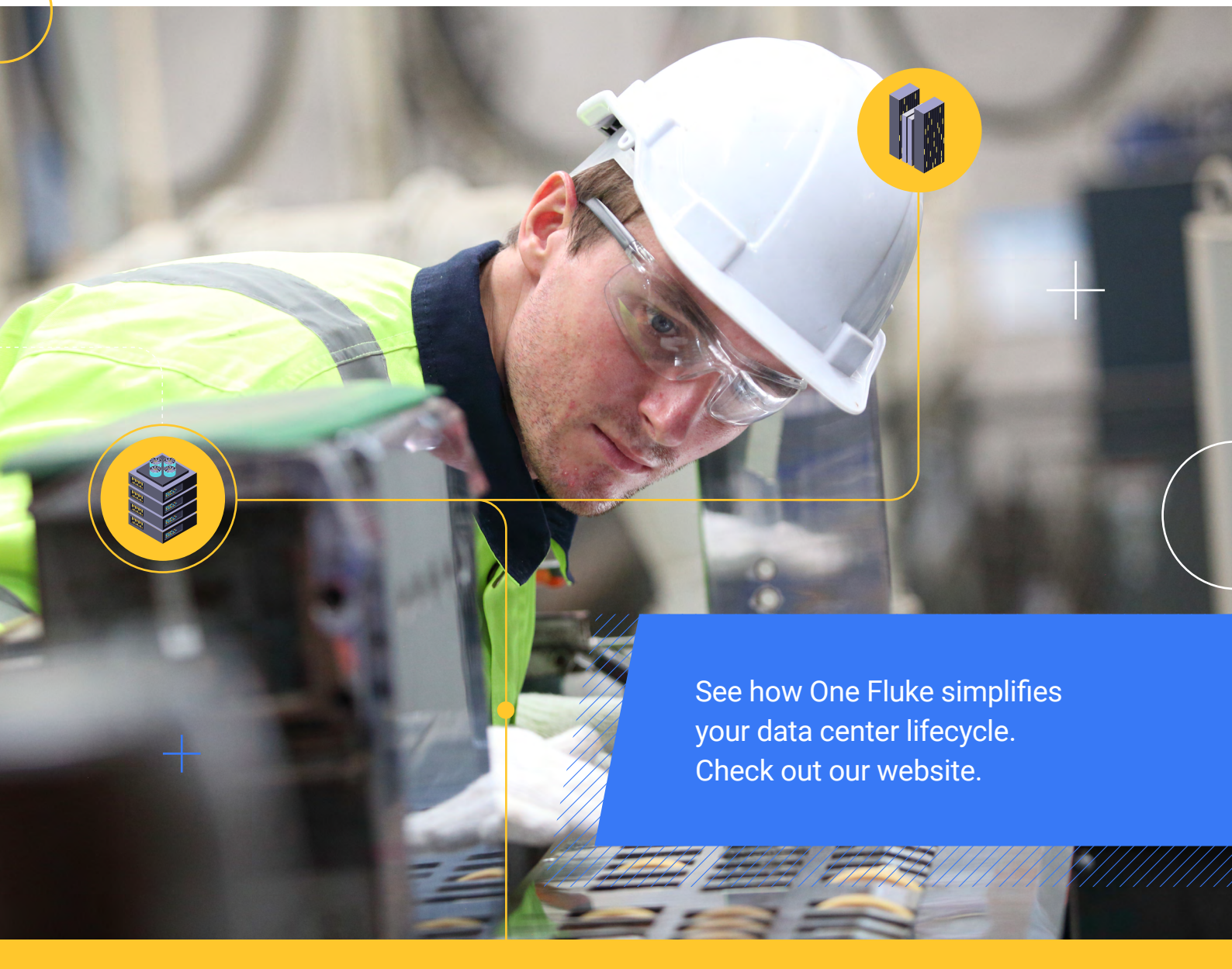
Phase shifting uses transformers with different phase angles to feed multiple rectifier loads, spreading harmonic currents across phases so they cancel each other out on the upstream system. When properly implemented, it can dramatically lower the THD found at the main service entrance.

Preventive practices for the future

One-time troubleshooting is not enough. Continuous harmonic monitoring needs to be a permanent part of operations, not a one-time fix, particularly as load profiles shift and new equipment is added. Regularly reviewing this data helps identify emerging harmonic issues before they lead to costly downtime or equipment damage.

When commissioning new power delivery systems, it's worth verifying that components such as inverters meet the performance criteria in project specifications, and that incoming utility power quality aligns with manufacturer requirements. Building harmonic checks into this process, and keeping clear documentation, establishes whether any power quality issues originate from the facility or the utility, which matters significantly if disputes arise later.

> Tools like Fluke Connect make logging and archiving power quality data straightforward, providing a traceable record that supports compliance, troubleshooting, and long-term reliability. Teams in the field can share live measurements with colleagues and upload data to a cloud location accessible from anywhere.



See how One Fluke simplifies your data center lifecycle. Check out our website.