Harmonics are all the frequency multiples above the base 50Hz, so 150Hz, 450Hz and many more.
Reports and standards prescribe attention to harmonics in the distribution grid.


PREDICTING TRANSFORMER END OF LIFE USING TRANSFORMER THERMAL LIFE SIMULATION TECHNIQUE

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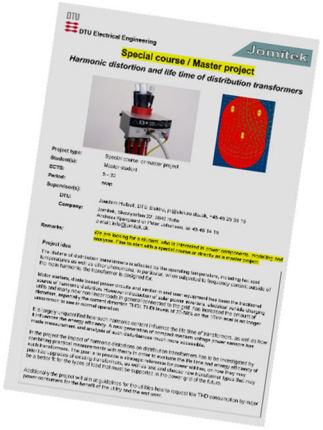
Reports

IEC 60364

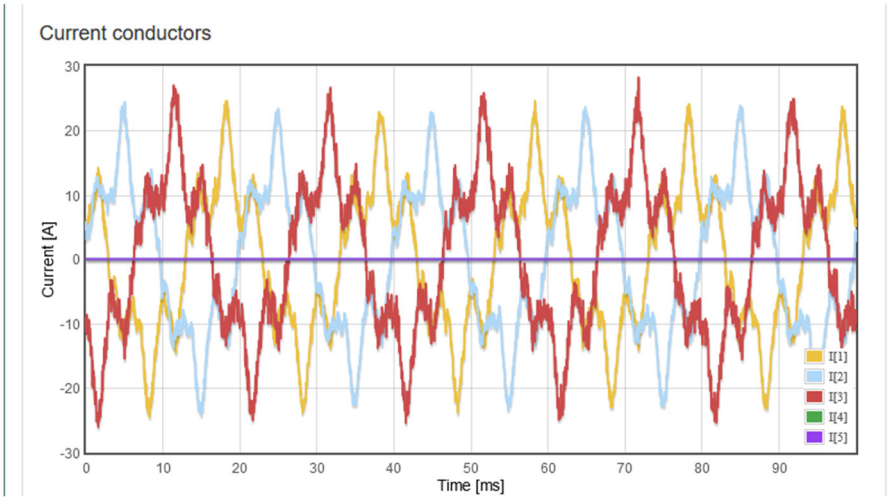


University projects

Harmonics result in power loss as heat and influences the life time of components, especially transformers.

Historically harmonics has been difficult to measure, especially harmonic currents.
New power generators like wind turbines and solar parks, generate much more harmonics, and new consumers in industry use more disturbing motor controllers and private consumers use more electrical vehicles also generating more harmonics.

This report gives examples how to use the simple I3 sensor to make the easy measurements.



Harmonics influence on transformer life time

The life time of distribution transformers is directly related to the temperature of the internal isolation material.
The isolation material is often made of paper and oil. The paper is made of cellulose. The break down voltage of cellulose degrades by age and by temperature.

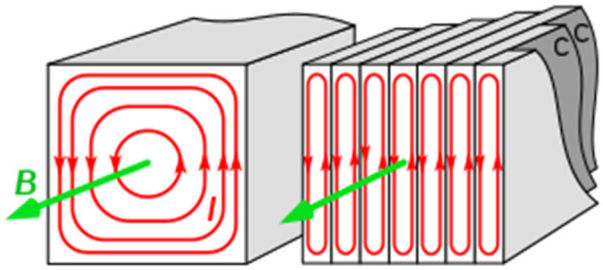
The internal temperature is related to the outside temperature, the transformer cooling and the power dissipation inside the transformer.
The power dissipation may be divided between:

- Magnetization loss
- Eddy current loss
- Stray loss
- Resistive loss

Most transformers are specified for 50(60Hz) conditions.
Measuring the transformer temperature is a good parameter to check, but inside the transformer some areas might become extra heated, called hot spots.

Whenever the transformer is running at any other and higher frequencies than 50Hz, the eddy current heating increase by **the frequency in power of 2 !** It is often seen that the Total Harmonic Distortion (THD), which is the sum of harmonics is at the 20% level. As an example, if just the 7'th harmonic = 350HZ is 5% then the Eddy current loss just due to this frequency is 7x7=49 times the 50Hz eddy current !

Jomitek participate in research activities in this field, and anyone interested in cooperation are wellcome to join by contacting Jomitek.



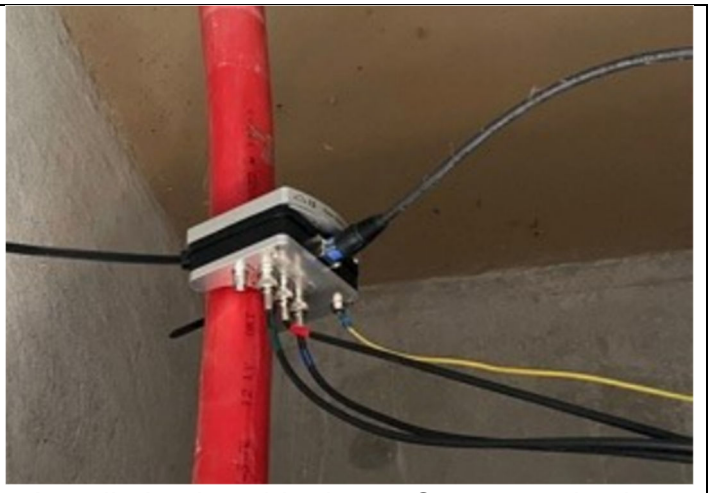
Eddy currents (red) in conducting material depends on the physical size

Basically the I3 sensor measures directly currents from the outside of 3 or 4 wire cables and measures voltage from capacitive connectors – so no transformers.

An installation kit, including LTE modem looks like this:

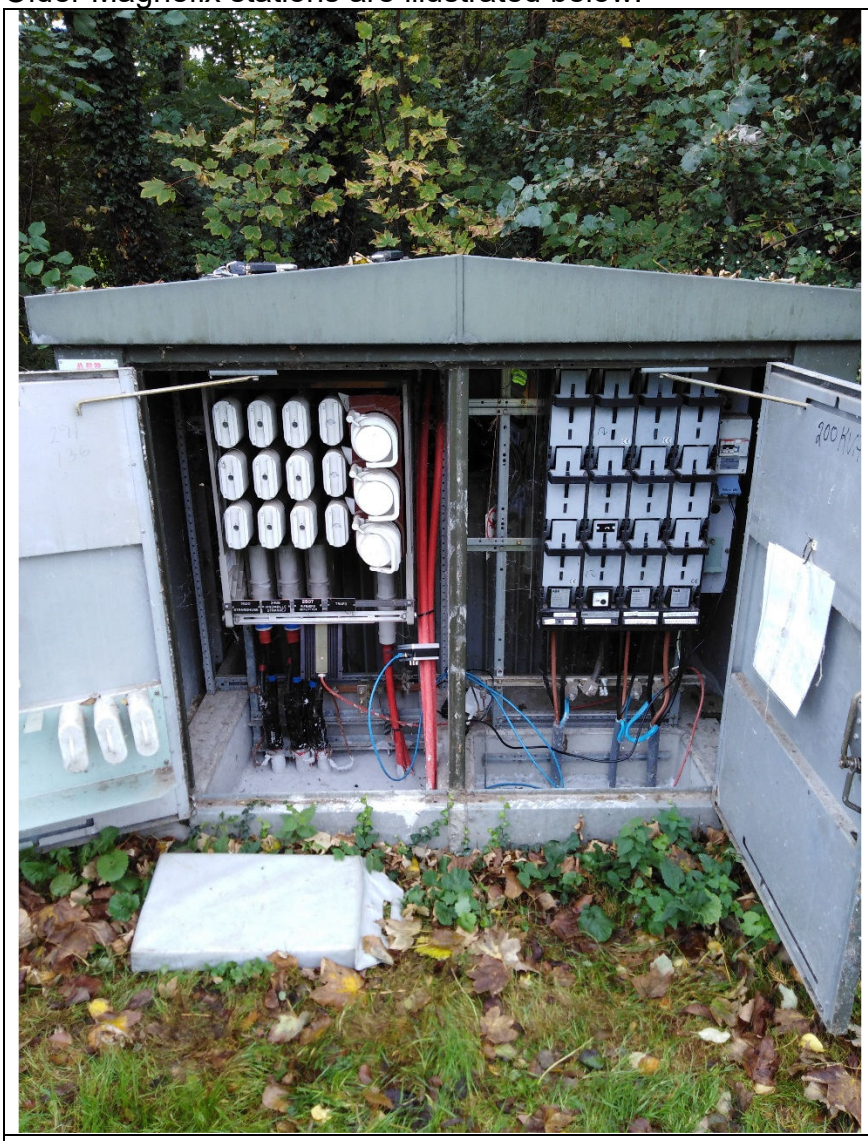
Some installation examples will follow here:

Installation at cable entry – only current measurement



Installation in cable duct – Current and voltage

Older Magnefix stations are illustrated below:



Above: Indoor installation on transformer connection

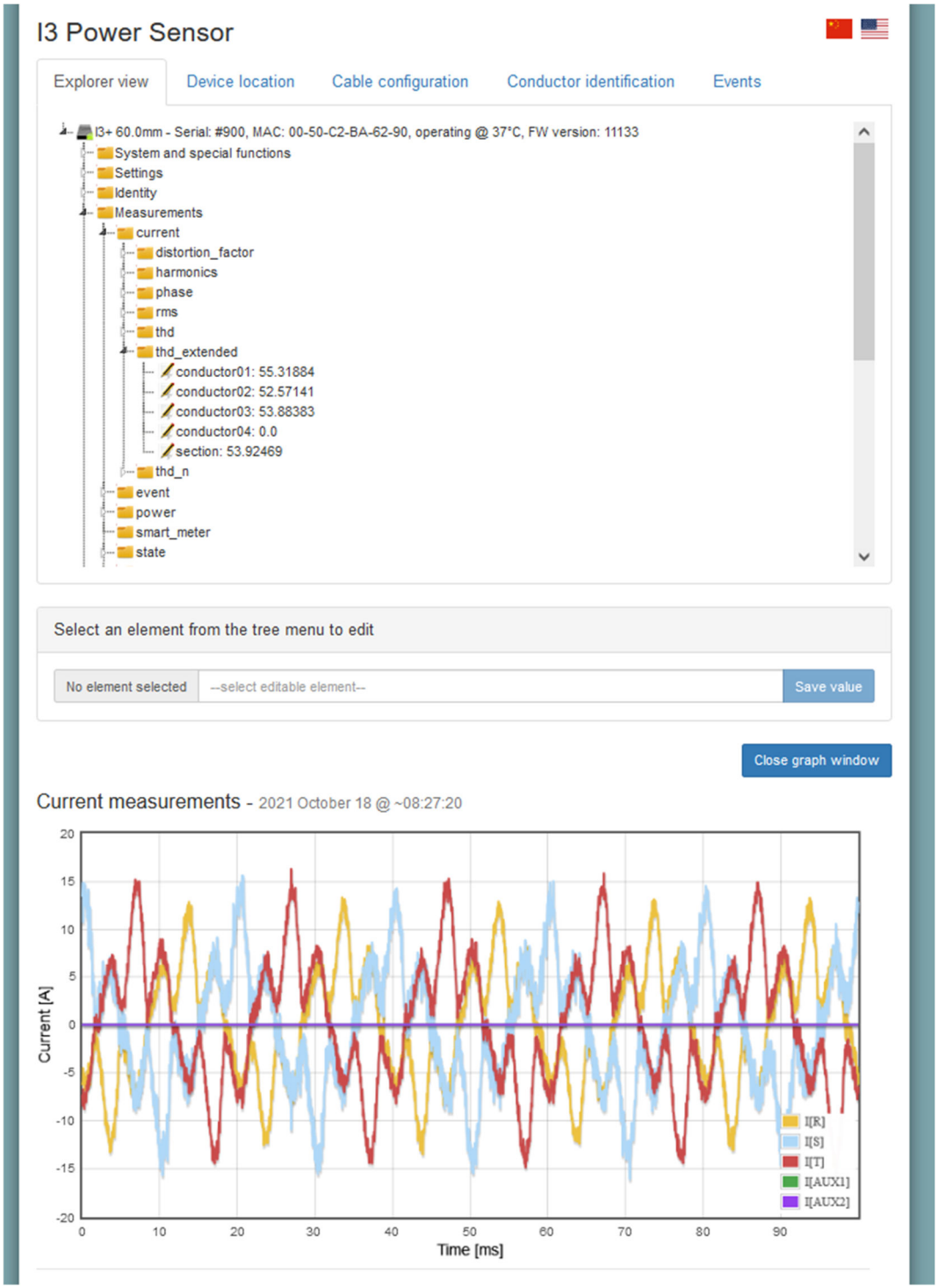
Left: Small secondary substation analysis of transformer currents

Voltage measurement outside on fuse-holders:

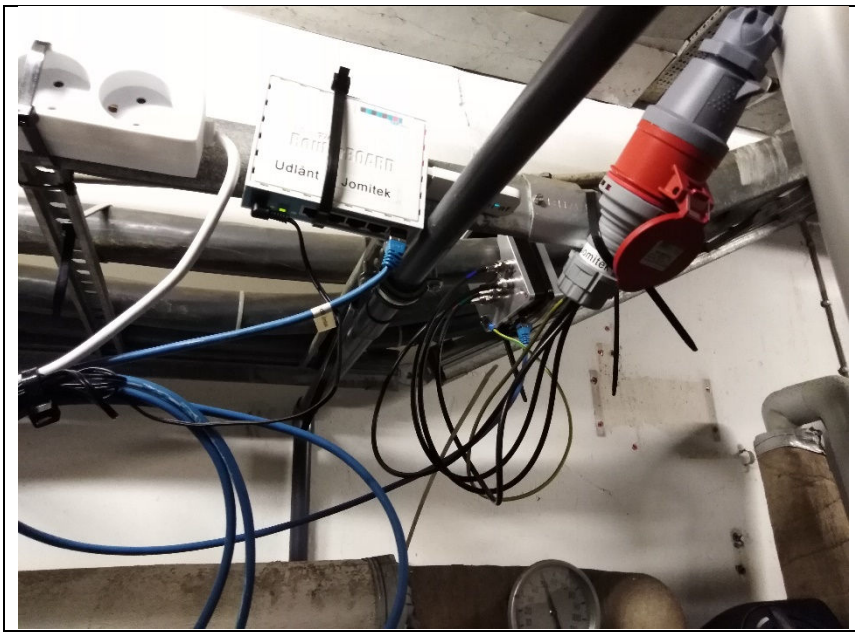
Immediate results by use of portable PC or just a phone via wifi.

		
3 Single 10kV conductors	3-wire conductor	3-wire conductor

Waveforms from HV side of distributions transformer:



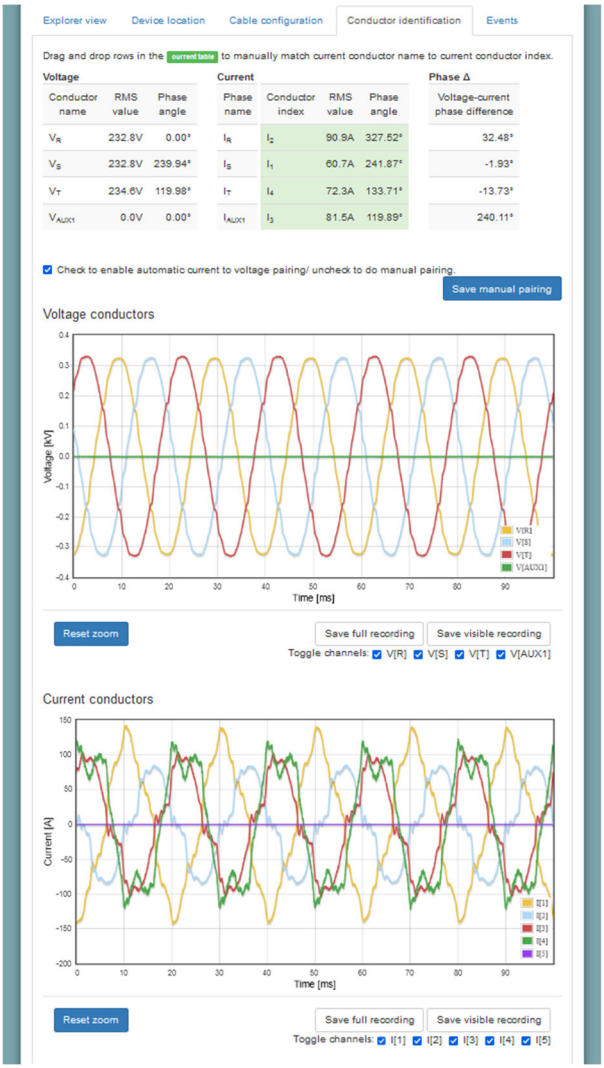
THD is more than 50 %, which is very high. Surprise for the operator of the grid.



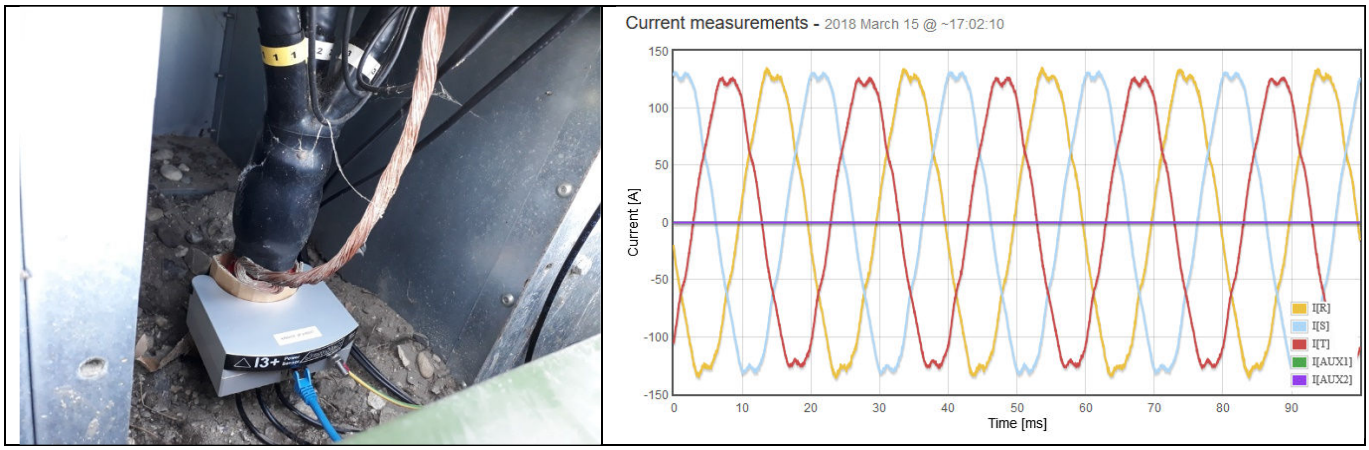
Fault analysis in 400V 4-conductor installation

Voltages looks fine but currents shows unbalance and harmonics.

Screen shot from web interface of sensor.



Substation having a solar park connected:



I3 sensor read out of harmonics: