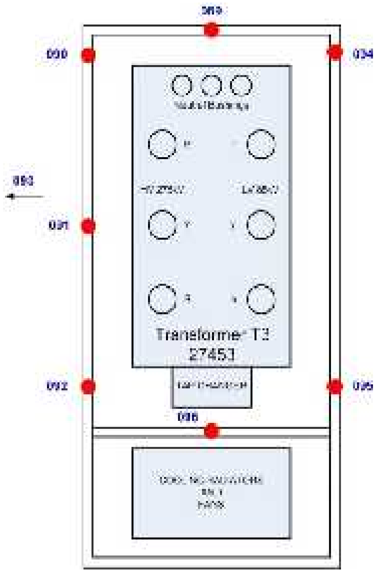
PDS100 Application Note:
The use of High Frequency Current Transformer as sensor for Transformer diagnostics

CASE STUDY 1 (Doble Client Conference 2011, ACCA committee meeting)

Dissolved Gas Analysis (DGA) carried out on a African, 275/88/11KV, 250MVA transformer shows signs of a discharge type fault. The DGA analysis is presented in Appendix A. RFI measurements and conducted EMI measurements (using a HFCT) were performed to establish correlation between the measurements.

Photograph of Transformer T3
FIGURE 1

Transformer T3
3-Ph Star/Delta
ASEA Type TMY55
275kV/88kV/11kV 250MVA
Year of Manufacture   1979



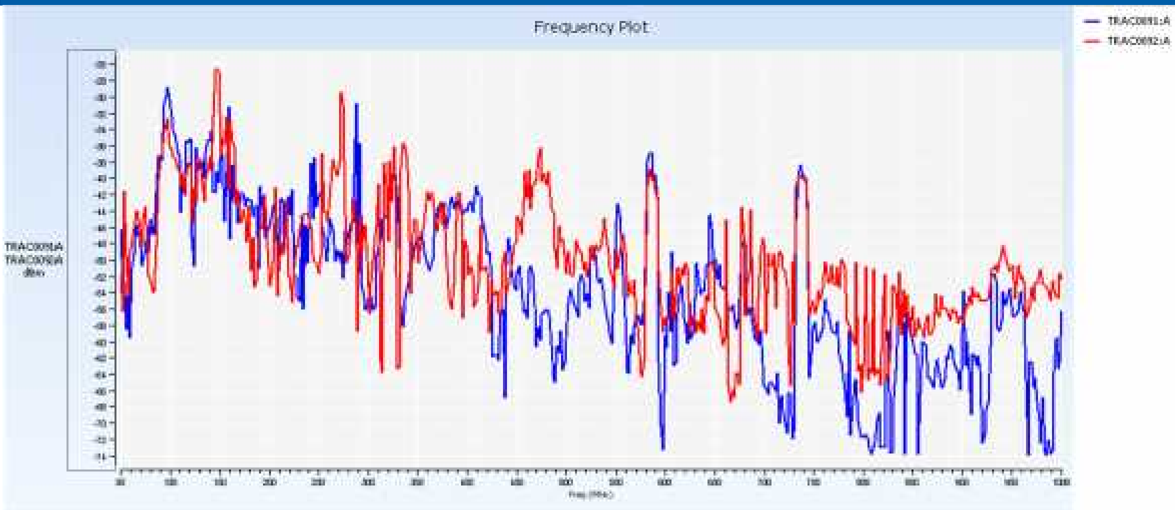
(a) Apparatus Detail **(b) Transformer Graphic Showing Measurement Points**

Details and Graphic of Transformer T3
FIGURE 2

Measurement of RFI Emissions

RFI measurements were taken around the periphery of the transformer, see FIGURE 2. The captured frequency traces are shown in FIGURE 3. The frequency traces exhibit a discrete appearance as pulses are accumulated. Short bursts of pulse accumulation were interspersed with long intervals of no or low energy activity. This represents a challenging measurement scenario. Pulses can be easily missed if the observation time is not sufficiently long enough to allow the resulting frequency scan trace to converge. Triangulation based on signal intensity of the higher frequencies locates the source of propagation in the vicinity of the HV B-phase (TRAC0091). Observing the RFI at 900MHz for a period of time in spot frequency mode sees the measured peak amplitude reaching -45dBm at that location. This mode also confirms the burst nature of the pulse sequence.

Measurements in time-resolved mode confirms the behaviour of the received pulse sequence i.e. characterised by very short burst activity interspersed by intervals of no or low energy activity. Pulses are received across the frequency range right up to 1GHz. There is evidence of significant attenuation of the measured RFI - the stronger peaks in amplitude are registered rather than the lower energy events. The behaviour observed is difficult to capture when attempting to save examples of the pulse sequence across the power cycle.



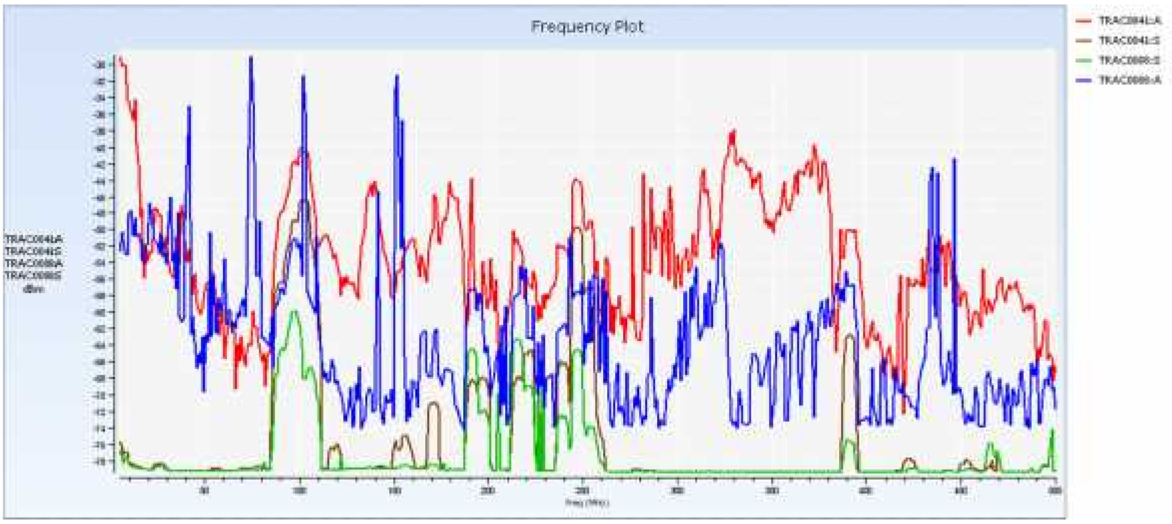
T3 RFI Peak Measurements
Legend: TRAC0091(pk), TRAC0092(pk)
FIGURE 3

Accompanying HFCT Measurements

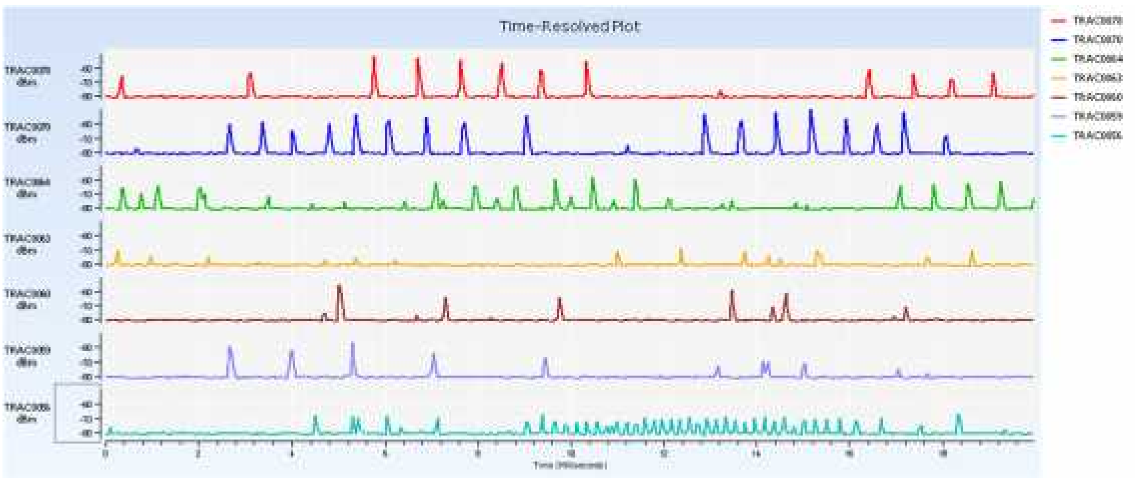
The conducted EMI is measured using a 300MHz split-core HFCT at the HV neutral connection to earth. The observed frequency measurements are plotted as TRAC0041 and are shown in FIGURE 5. Note the connection arrangement shown in FIGURE 4. An additional measurement point is located further down the earth strap from the neutral connection. This is plotted as TRAC0088. It can be noted that the received frequencies are subjected to attenuation the further away the measurement point is from the neutral connection. The measured conducted EMI is subjected to significant attenuation through the HV neutral connection and requires an extended observation time to arrive at the traces in FIGURE 5.

HFCT on T3 HV Neutral Connection
FIGURE 4

In time-resolved mode both the RFI and conducted EMI measurement confirm the measured pulse behaviour. However the pulsed activity is more easily captured and more of the lower energy pulses are detected. FIGURE 6 shows examples of the pulse sequence received at a number of spot frequencies. Corona is evident in the lower frequency traces. The observed discharge pattern is strongly correlated to the power cycle, repeatable in behaviour and having a symmetry over both half power cycles in terms of repetition rate and amplitude distribution. Amplitudes are nearly constant as is phase resolution between consecutive pulses. The dynamic behaviour of the activity is characterised by very short burst activity interspersed by intervals of no or low energy activity. The sequence exhibits the characteristics of a floating type discharge. A secondary source of discharge is evident in the time-resolved traces. The results confirm that the conclusions drawn form the DGA analysis.



HFCT Measurements on the Neutral/Earth Strap
Legend: TRAC0041(pk), TRAC0041(avg), TRAC0088(pk), TRAC0088(avg)
FIGURE 5



HFCT Time Resolved Measurements on the Neutral/Earth Strap
FIGURE 6

APPENDIX A

Transformer T3 – DGA Analysis and Observations

Transformer Details

The transformer details are given in Table A.1 below:

Table A.1
Transformer Details

Substation			
Circuit	T3		
Serial Number			
Manufacturer	ASEA		
Year of Manufacturer	1979		
Voltage	275/88/11 kV		
Rating	250		
Impedance	Tap 1	Tap 10	Tap 17
	27.6 %	25.2 %	24.9 %
Cooling	ONAN/ONAF		

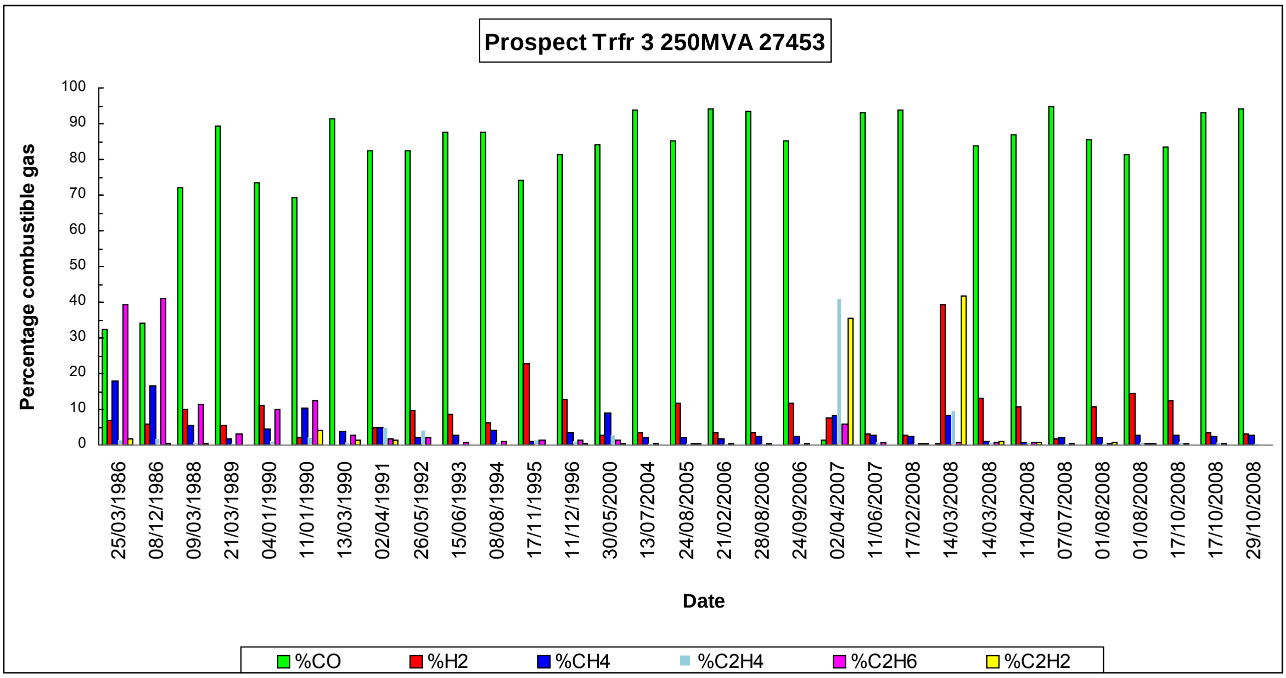
Condition Analysis

Oil Assessment

a) Oil Condition
The oil quality indicators that of moisture content, relative saturation, acidity and dielectric strength, all indicate normal aging of the oil for this transformer.

b) Paper Degradation
Unfortunately, the concentrations of the paper degradation product 2-furfural (2FAL) was not measured in the oil; as a result the condition of the paper insulation cannot be assessed with confidence.

c) DGA Interpretation
The DGA signature is indicative of a discharge fault. This is shown in Figure A.1.



DGA Signature

FIGURE A.1

Visual Inspection

The visual inspection revealed the following:

a) oil leaks from the radiators, main tank and bucholz; and
b) Fan 9 is removed.

Infra Red

The IR scans revealed no overheating.

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