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REMOTE MAINTENANCE for FACILITY EXPLOITATION

WP4 INTERNAL REPORT

SPECIFICATION OF EFI FUNCTIONS

Monitor (Generator) Circuit-Breaker Operating Mechanism Condition (S3)

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PREFACE

This document describes the maintenance function «Condition Monitoring of Generator Breaker Operating Mechanism» (S3).

It is a rather general description on how an excisting technique for periodic diagnostic testing of circuit-breakers can be implemented in a system for continuous monitoring. Data acquisition, analysis and storage are treated in general terms; no detailed specifications of file formats, communication protocols etc. are ready at this stage.

1. OBJECTIVE OF THE FUNCTION

The function interfaces an MMT (Maintenance Monitoring Tool) that monitors the mechanical condition of the operating mechanism of the generator circuit-breaker in a power plant.

The monitored is performed by considering the mechanical vibrations generated when the breaker is operated. The vibration patterns or «signatures» are compared with a reference, e.g. a recording from a previous breaker operation. If deviations occur, this signifies that the mechanical condition of the device has changed, indicating that further examinations, inspections or maintenance should be carried out.

2. FUNCTION ENVIRONMENT

Most of the data acquisition, analysis, evaluation and storage is carried out by the MMI, see attached figure.

The MMI automatically acquires and analyses the vibrations patterns after each circuit-breaker operation. The output of this analysis is two deviation vectors, each of a predetermined length of typically 100 elements. These vectors are transferred to the LMS and further to the CMS database, and can be displayed at the CMS. If the deviation exceeds a predetermined level, an alarm signal is generated and presented for the CMS operator.

Furthermore, the raw data (i.e., the vibrations signatures) from all measurements are stored as files at the MMT, and they can be accessed through ethernet calls and be displayed at the CMS.

The measurements are identified by circuit-breaker phase, circuit-breaker operation type (close or open) and number, and sensor position.

3. INFORMATION FLOW AND STORAGE

See enclosed figure for outline of data flow in excisting stand-alone instrument for diagnosis of circuit-breakers.

In a REMAFEX implementation information flow and storage could be as indicated in the following:

Local set-up parameters for MMT system
These are not to be changed by REMAFEX function.

Circuit-breaker identification	(6 character string)
Number of channels	(integer)
Sampling rate	(integer)
Numbers of samples per channel	(integer)
Scaling/preamp. gain for each channel	(6 elem. real vector)
Identification of reference signature set	(file names)

Information acquired and stored in MMT:
Triggered by the 200 volt command signal to the circuit-breaker, the MMT acquires vibration signatures according to the set-up:

C.-b. operation type (close or open)	(integer)
C.-b. operation number (counter)	(integer)
Date and time for c.b.operation	(time format)
Vibration signatures, for each channel	(typically 4000 elem. ..... binary vector)

Information calculated by MMT:

After each circuit-breaker operation the MMT calculates the deviation vectors:

Signature deviation, for each channel	(typically 2 x 100 ..... elem. real matrix per ..... channel)

Information transferred from MMT to REMAFEX:
After each circuit-breaker operation the following information is transferred to, and displayed and stored by REMAFEX:

C.-b. operation type (close or open)	(integer)
C.-b. operation number (counter)	(integer)
Date and time for c.b.operation	(time format)
Identification of reference signature set	(file names)
Signature deviation, for each channel	(typically 2 x 100 ..... elem. real matrix per ..... channel)
Alarm status (based on threshold value)	

Interactive mode:

In addition to this automatical or continuous mode, it must be possible for a CMS operator to have access to the raw data files (i.e. the vibration patterns) in the MMT database. This in order to be able to look directly into the vibrations patterns and thereby find information about what the reason for a deviation is. In this interactive mode, a zoom option should be available.

NOTE: The existing stand-alone unit for periodic testing of circuit-breakers that uses this method has already established procedures for several of the taske described above. To the extent it is possible, information handling and storage inside the MMT should be based on the same formats and procedures. This would reduce the amout of work required, and would also make it possible to compare signatures obtained in continuous system like the REMAFEX with signatures obtained with the stand-alone unit.

4. DYNAMIC BEHAVIOUR

The MMT is continuously sensing on the command signal for the generator circuit-breaker, and the data acquisition is triggered by the command signal. (Generator circuit-breakers operates typically 0 - 20 times a week.) The analysis part, i.e. the comparison with a reference, is carried out as a batch process.

If the maximum deviation in frequency content or in timing exceeds a predetermined level, a warning signal is generated automatically and displayed immediately.

5. DATA PROCESSING (ALGORITHMS)

A digitized vibration pattern amounts to typically 4 - 10 ksamples of data. The algorithm that compare two vibration signatures involves Fourier analyses and is, therefore, rather CPU-demanding.

Output is to vectors: i) Deviation in frequency content, and ii) Deviation in timing, both as a function of time over the typically 100 ms a breaking operation lasts. Both vectors have one element per millisecond.

The algorithm has been extensively tested and has proven to be sensitive for detecting deviations and at the same time sufficiently robust (very few false alarms).

6. INTERFACES

6.1. OPERATOR INTERFACE

On request the deviation vs. time curves for the various phases should be displayed as graphs at the CMS.

Furthermore, if the calculated deviation values exceed the warning threshold an alarm signal appear.

In addition, an interactive mode for displaying the raw data should be available.

7. HARDWARE AND SOFTWARE REQUIREMENTS

As most of the data acquisition, analysis and storage is done by the MMT, no unusual requirements exists.

8. ANNEXE - FUNCTIONS INPUT DATA

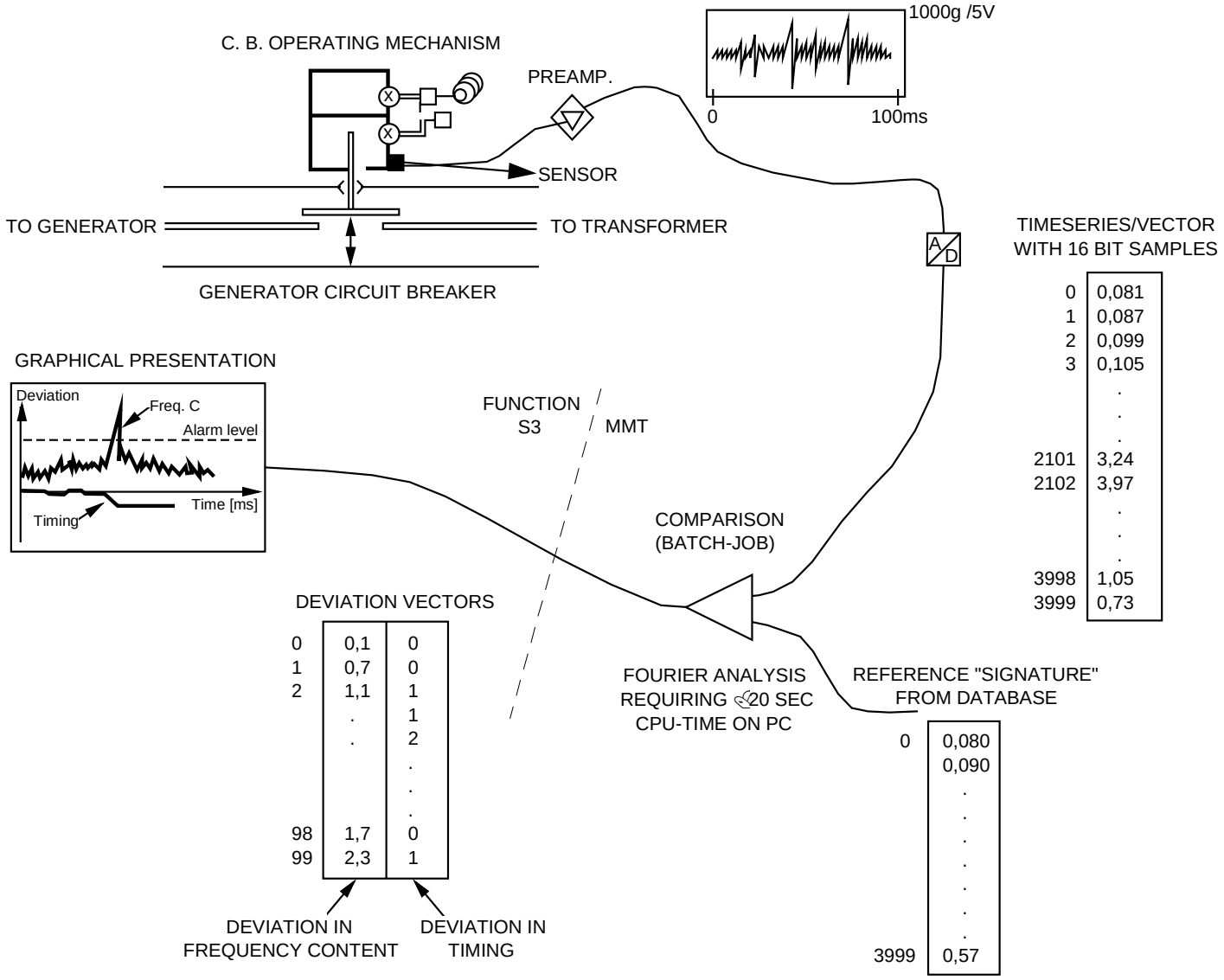
FUNCTION: Condition Monitoring of Circuit-Breaker Operating Mechanism (S3)

Item	**Circuit-Breaker**
Domain	**Supervision/Monitoring**
User Need	**To request circuit-breaker operating condition**
Function	**Condition Monitoring of Circuit-Breaker Operating Mechanism**

No.	System, Subsystem	Component, Subcomp.	Parameter	State	Type	Unit of measure	Range	Alarm value	Trip value	Remarks	Data label
1.	Switchgear, Circuit-breaker	Operating mechanism	Deviation matrix (typ. 3 x 100 elem.)		Numeric	dB and msec	[0,25], [-10,10]				<site>_SW_CB_OM_#DEVMAT

In addition, information identifying the circuit-breaker, the operation type (close or open), the opeation number, and sensor location should be transferred from the MMT to REMAFEX (in the form of a file heading, name or in another way).

APPENDIX 1


C. B. OPERATING MECHANISM
PREAMP.
1000g /5V
0
100ms
SENSOR
TO GENERATOR
TO TRANSFORMER
GENERATOR CIRCUIT BREAKER
A/D
TIMESERIES/VECTOR
WITH 16 BIT SAMPLES
0 0,081
1 0,087
2 0,099
3 0,105
2101 3,24
2102 3,97
3998 1,05
3999 0,73
GRAPHICAL PRESENTATION
Deviation
Freq. C
Alarm level
Time [ms]
Timing
FUNCTION
S3
MMT
COMPARISON
(BATCH-JOB)
DEVIATION VECTORS
0 0,1 0
1 0,7 0
2 1,1 1
1
2
98 1,7 0
99 2,3 1
DEVIATION IN
FREQUENCY CONTENT
DEVIATION IN
TIMING
FOURIER ANALYSIS
REQUIRING ≈20 SEC
CPU-TIME ON PC
REFERENCE "SIGNATURE"
FROM DATABASE
0 0,080
0,090
3999 0,57