Flickermeter Comparison Test

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Abstract—**The paper describes the test of flicker evaluation made by eleven different types of power quality analyzers. The standard IEC 61000-4-15Ed.2 (Functional and design specification of flickermeter) issued on August 2010 specifies performance testing. Existing flickermeters from different manufacturers may provide different results when processing non-uniform voltage fluctuations. The flickermeters response to voltage varying signals with envelope shape typical for sawmill, heat pump, granulator was tested. Voltage fluctuation caused by operating of this electrical equipment was measured in the real low voltage distribution network by means of the power quality analyzer Topas 1000. One-period records of voltage fluctuation were available for the analysis. These were simulated on the programmable power voltage source HP6834B in the university lab.**

Keywords—Flicker, power quality analyzer, flickermeter, voltage fluctuation

I. Introduction

Liberalization of the electricity market brings considerable pressure to introduce penalties for inconvenient voltage quality parameters. These penalties should be the nature of the rebate payments for electricity, in case of poor voltage quality. In case of detection of unsatisfactory voltage quality because of the customer complaints, it is necessary to take some corrective action. If the correction action is not done in specified time limit this can be another reason for DNO penalties. It has been shown that the most common parameter in the LV distribution network negatively affecting the voltage quality within the meaning of EN 50160 [2] is the level of flicker. Correct evaluation of this parameter is crucial for DNO's in terms of:

- The voltage quality complaint settlement on customer side
- The choice of technical solutions in the suppression of flicker
- The amount of investment funds deposited into the distribution network in order to suppress flicker

From the above mentioned information follow the demands for Power Quality analyzers, which are intended to verify compliance with the requirements of EN 50160 [2]. When different types of PQ analyzers are measuring on the same site in the same measurement period, then identical results should be obtained. Otherwise the choice of the PQ analyzer type, in case of unsatisfactory PQ result, has resulted in the need for different technical measures.

II. Technical Equipment

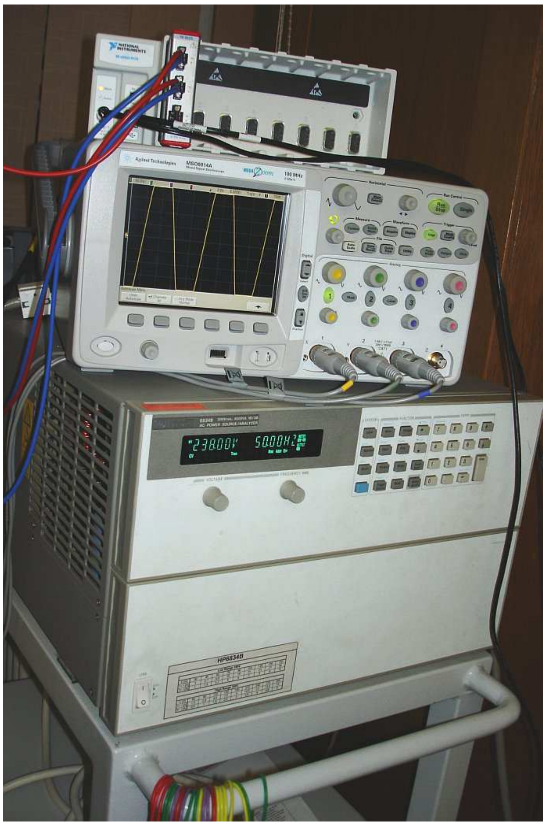

Fig. 1. Programmable power source HP6834B, AGILENT oscilloscope, National Instruments cDAQ chassis with NI9225 module

All the tests described below were conducted at the Department of Measurement and Control, Faculty of Electrical Engineering and Computer Science, VSB-Technical University of Ostrava. Voltage changes were simulated on the programmable power source Agilent HP6834B. The source is a high-performance device, with a rating up to 3kW, so it is not a problem to provide power supply to the tested devices from it. An application for controlling the HP6834B source was developed in LabVIEW, allowing controlling the source via a GPIB interface. A combination of the source and a control PC can be provided for a broad range of voltage changes. The generated progress was verified by an independent measuring application created in LabVIEW, using the following hardware: cDAQ chassis, which can be connected to a PC via a USB port, and NI9225 module that offers three galvanic separated voltage inputs with a range of 300V. The whole assembly, together with the AGILENT oscilloscope, is shown in Fig. 1.

III. Test Number 1

Test was realized in February 2010. Six power quality analyzers were tested. Publication of the results of test 1 inspired a vivid discussion among professionals and further interest in testing other devices. The test results allowed one of the manufacturers to detect an error in the firmware: only one device, declared by the manufacturer as a class B analyzer under EN 61000-4-30 [3], showed very different results for flicker evaluation. Distribution system operators, consultancy companies and producers of PQ analyzers expressed interest in verifying devices used, traded or manufactured by the companies. This is why another test was undertaken, with some additional tests (unlike the previous test) under the latest IEC 61000-4-15 Ed.2 [1].

Fig. 2. Picture of the tested PQ analyzers

IV. Test Number 2

The test was performed in September 2010 and included 11 different PQ analyzers, see Fig. 3.

Fig. 3. Picture of the tested PQ analyzers

The following devices were tested:

- Topas 2000,(S/N TN92562BA, Fluke)
- Fluke 1744, (S/N Y621466CA, Fluke)
- MEG30, (S/N 60034, new FW, Mega)
- MEG30, (S/N 60036, Mega)
- ENA 450, (S/N EVAV090011, ELCOM)
- ENA 330, (S/N EVAV070002, ELCOM)
- ION 7600, (S/N PL0107A08001, Schneider)
- ION 7650, (S/N.PJ-0605A029-01, Schneider)
- MI 2292, (S/N 09510131, Metrel)
- PMD-A, (S/N 40229256-PMDA01, Qwave)
- SMPQ44, (no S/N provided, KMB)
- Simon PQ, (no S/N provided, KMB)

The MEG30 S/N 36 analyzer is still furnished with the original firmware version. The test results allowed the manufacturer to identify an error in the firmware and the MEG30 No. 34 analyzer contains a new firmware version with a corrected algorithm for the flicker evaluation. Furthermore, the progress of voltage changes typical for some appliances is described. The test is not defined by the IEC standard and is called an "operating test".

A. Granulator

A granulator in operation exhibits fluctuating load, mostly without idle run. The operation of the granulator and the consequent power consumption result in an ever-changing RMS network voltage without delays where voltage changes would not occur. Therefore, it is possible to except the flicker progress without major changes.

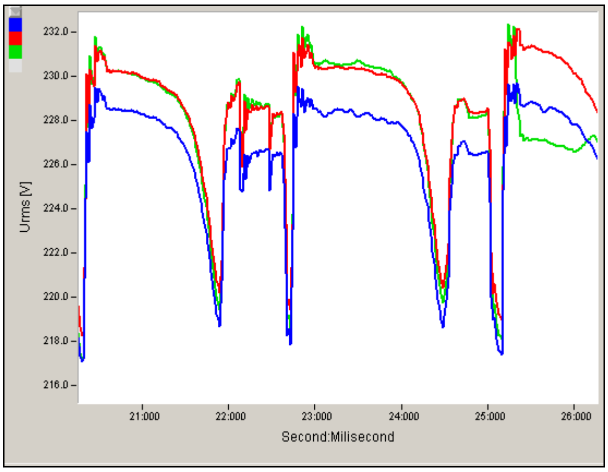

Fig. 4. Detail of Urms changes in the granulator connection point, voltage changes Up-p 11V, change interval 2.4s

B. Sawmill

A sawmill is operated in the mode in which the operator handles the processed materials, i.e. it runs without any load for some time, followed by an interval for cutting, i.e. causing irregular network load, see Fig. 5. Irregular network load causes a changing level of RMS voltage value and, depending on the ratio of idle run and operation under load a changing flicker value can be expected.

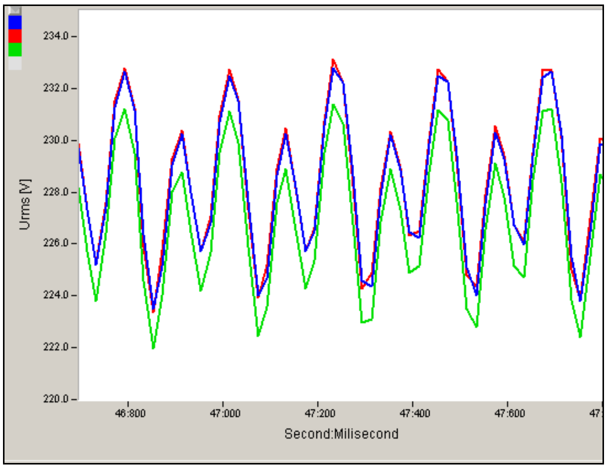

Fig. 5. Detail of Urms changes in the sawmill connection point - voltage change interval T = 220 ms, voltage changes Up-p 9V

C. Heat Pump

The heat pump causes decreases, typical for rapid voltage changes. If the heat pump is switched on, there is a high current peak caused by the switching on of a cage inductor motor. When the motor starts, the current peak fades and the motor runs at the nominal current. After some time, the heat pump is switched off, current drops to zero and the voltage gets back to the original value. The described process causes irregular network load, with a specifically long time when the pump is on and off (during the simulation, the intervals were 15 and 15 minutes). The irregular network load causes infrequent changes of the RMS voltage value and a highly varying flicker value can be expected.

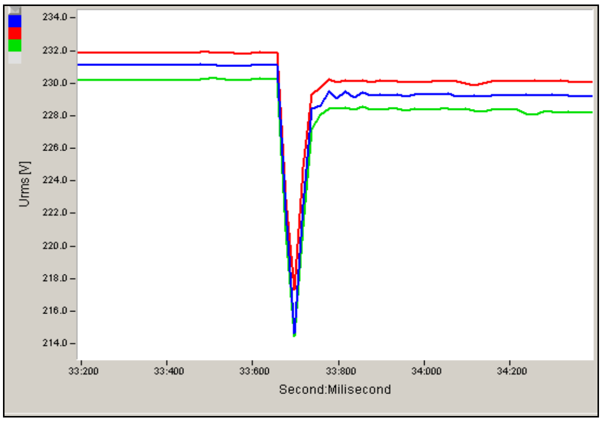

Fig. 6. Detail of Urms changes at the time of actuation of an actual heat pump, change duration 100ms, change depth 16V

D. Other Signals

Constant sinusoidal signal with the presence of cyclically repeated telegram Signalling Voltages at the frequency of 216.66 Hz and 9 % amplitude.

Constant sinusoidal signal with the presence of cyclically repeated telegrams Signalling Voltages at the frequency of 216.66 Hz and 2 % amplitude, harmonic voltage: 5 h. 6 % Un, 15 h 0.5 % Un.

E. Results of Performed Tests

The results are summarized in the single Table I. The legend is as follows: SM (Saw Mill), GR (Granulator), HP (Heat Pump), SV (Signalling Voltages), SV+h (Signalling Voltages and harmonics).The table clearly shows that the evaluated results vary. The Meg30 S/N 36 instrument was operated with the original firmware with an erroneously evaluating flicker, while the Meg30 S/N 34 instrument is already modified. Another remarkable result is that of the Fluke 1744 instrument shows zero for low flicker values.

TABLE I.
COMPARISON OF PST FLICKER BY TEST NO 2

	Flicker Pst				
	SM	GR	HP	SV	SV+h
Topas 2000	4,05	2,31	0,88	0,61	0,15
Fluke 1744	4,18	2,23	0,90	0,63	0,00
MEG30 #34	4,50	2,05	0,93	0,66	0,13
MEG30 #36	2,71	2,33	0,21	0,56	0,12
ENA330	3,93	2,24	0,85	0,58	0,13
ENA450	3,92	2,24	0,86	0,59	0,13
Metrel	4,25	2,34	0,90	0,78	0,17
Qwave	3,90	2,26	0,86	0,59	0,13
ION 7650	4,00	2,35	0,89	0,73	0,15
ION 7600	4,05	2,31	0,88	0,61	0,15
SMPQ 44	4,01	2,29	0,89	1,11	0,26
Simon PQ	4,01	2,29	0,88	1,09	0,25

F. Tests according to the Standard IEC 61000-4-15

The testing of functionality of the flickermeter based on the standard [1] is performed for instantaneous flicker Pinst and short-term flicker Pst. None of the devices is in the test records Pinst. For time reasons, the tests were not performed for all of the prescribed test conditions. The sequences of the tests were selected to utilize the time for test performance as much as possible. The following tests were performed.

Test 6.1 of standardized response of the flickermeter for rectangular voltage fluctuations. It is performed on the basis of standardized response tables and the test measures output instantaneous flicker Pinst. Pinst, max shall be equal to 1.00, with a ± 8 % tolerance. Since the test signal prescribed in the standard was generated for 70 minutes, it is possible to use the equivalent value Pst for verifying Pinst in this case. Reading from the FLUKE 61000A calibrator was used to find the equivalent value Pst, where the calibrator shows the value Pst on its display for the selected type, depth and frequency of modulation. Results of above described test are summarized in the Table II.

Test 6.2 of the classifier in block 5 of the flickermeter. Rectangular modulation is used for the test as stipulated in the prescribed table. The Pst output is tested; the output shall be equal to 1.00, with a ± 5 % tolerance. Results of this test are summarized in the Table III.

TABLE II.
COMPARISON OF FLICKER PST BY TEST 6.1

	Test 6.1, Pinst=1			
	8,8Hz, 0,196%, Pst=0.74	18Hz, 0,446%, Pst=0.56	25Hz, 0,746%, Pst=0.49	33,33Hz, 1,671%, Pst=0.70
Topas 2000	0,77	0,71	0,69	0,72
Fluke 1744	0,73	0,67	0,64	0,64
MEG30 #34	0,79	0,73	0,71	0,62
MEG30 #36	0,71	0,56	0,39	0,20
ENA330	0,72	0,66	0,64	0,65
ENA450	0,72	0,66	0,64	0,65
Metrel	0,75	0,66	0,57	0,64
Qwave	0,72	0,72	0,67	0,69
ION 7650	0,72	0,65	0,58	0,72
ION 7600	0,77	0,71	0,69	0,72
SMPQ 44	0,76	0,70	0,67	0,69
Simon PQ	0,75	0,71	0,65	0,68

TABLE III.
COMPARISON OF FLICKER PST BY TEST 6.2

	Test 6.2, Pst=1			
	1 CPM 2,715%	2 CPM 2,191%	7 CPM 1,450%	39 CPM 0,894%
Topas 2000	0,98	0,97	0,98	1,00
Fluke 1744	0,99	0,98	0,96	0,97
MEG30 #34	0,98	0,96	0,97	0,97
MEG30 #36	0,53	0,62	0,78	1,00
ENA330	0,95	0,94	0,95	0,97
ENA450	0,94	0,94	0,95	0,97
Metrel	0,97	0,98	1,00	1,01
Qwave	0,96	0,95	0,96	0,98
ION 7650	0,98	0,98	0,98	0,99
ION 7600	0,98	0,97	0,98	1,00
SMPQ 44	0,97	0,97	0,97	0,98
Simon PQ	0,97	0,96	0,97	0,98

G. Evaluation

The results of the tests carried out on the basis of a definition in the standard specified in this chapter are not aimed to substitute a calibration protocol from an accredited laboratory. The chapter only describes what was tested and presents the results. However, it is necessary to draw the readers' attention to some of the results evaluated by the instrument MEG30 with the original firmware, which had been used for a long time until June 2010, when the manufacturer corrected the firmware.

V. CONCLUSION

The information above shows that it is necessary to test the PQ monitoring devices and evaluate the results. It is obvious from the results of the tests mentioned above, prescribed in the standard or reflecting the conditions commonly occurring in practice that in spite of many uncertainties in the definition of a flickermeter [1], the different types of devices from different manufacturers yielded quite identical results. In the whole test authors focused on the short-time flicker Pst. The reason is, that instant the flicker P(t) data are not provided by any instrument involved in the test. The relation between the long-time flicker Plt and the short-time flicker Pst is clearly defined in [1] by the exact formula, anyway there can be differences among particular manufacturer. The field of flickermeter testing or more broadly, the field of PQ analyzer testing, is important for practice. The Department of Measurement and Control, VSB-Technical University of Ostrava will continue testing other parameters of PQ analyzers.

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