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Industrial Calibration System Based On IOT

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Abstract—Calibration system has been developed to aid in development and evaluation of a control algorithm for electronic spark advance. It consists of the programmer, controller and measurement units. Given the spark advance and the dwell time in the form of function subroutines written in controller, the programmer unit makes the advance and dwell tables as a function of instrument speed and load. Referring to these tables, the controller unit operates the secondary instrument under calibration. The measurement unit measures the resultant motor performance and analyses the control algorithm. This process is repeated until the optimum algorithm is reached. A few test examples are also presented to demonstrate the system capability. This system features an easy operation and accurate calibration.

Index Terms— Smart grid, voltage sensors, current sensors, calibration, non-sinusoidal conditions.

1.INTRODUCTION

Elegant grids come up as a product of world-wide evolutionary development of the command system. When, at the opening, there were small district grids where loads and production competence were more or less in stability, there was not much need for inter associates to the nearest grids and also there was no obligation to know what was happening outside, With situation to the communication and allocation net-works, smart electrical energy and modern sensors, with amplified performances in terms of high accuracy and wide frequency bandwidth are thus required in the new smart grid circumstances. Therefore, aiming at sensors which can be used for correct measurements in a large frequency range, the scientific neighbourhood is fundamentally focused on two tasks: design of new measurement transducers/transformers with augmented performances and advance of gesture dispensation techniques to recover procedure of active transducers. Anyway, a dilemma still remainder, that is the accessibility of quantity setups and methods for the calibration of sensors in a wide frequency range. The production signals of the sensor underneath calibration, in statement, should be measured and compared with those coming from a mention one in an unlimited range, which includes at least the harmonics up to the 50th. The classical control and breathing comparator bridges do not tolerate the calibration of all the transformers and can normally manage in a lacking frequency range (e.g. 50 Hz, 60 Hz, 400 Hz)The paper describes a scrutiny set for the calibration of voltage and modern sensors, both conventional as well as non-conventional, for smart grid applications. It allows the calibration with typical waveforms of smart grid scenario that is under sinusoidal and non-sinusoidal surroundings and in assortment of occurrence from DC to tens of kilohertz. The system is intentional for use in developed laboratories, so therealization is a low cost calibration company, with a moderately effortless make-up, but at the same time categorized by good metrological performances. In the following, after a concise reassess of the calibration techniques and instrumentation for old-fashioned and non-conventional transformers, the realised test set is presented.

II.CALIBRATION OF DEVICE TRANSFORMERS

The calibration of power and modern transformers, both conservative (CVT and CCT) as well as non-conventional (NCVT and NCCT) and the related instrumentation for their calibration is a widely discussed topic in scientific and technical literature [19]–[30], as briefly and, for the sake of the summarized in the following. As it is well known, apposite calibration set-ups, based on the evaluation method, have been then developed accordingly. These systems cannot be directly engaged for the appreciable characterization of the non-conventional low supremacy output current/voltage transducers.

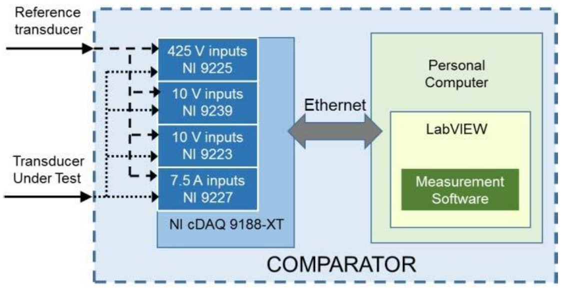

Fig. 1.Block diagram of the realized comparator.

As it can be seen, numerous comparators have been designed to work in a wide assortment of frequencies, both with predictable as well as non-conventional transformers. Never the less, some boundaries have to be painstaking. First of all, they need the use of further reference transducers for the reduction and/or translation of the voltage/current signals to be compared. Moreover, their costs are generally high and some of them do not allow the calibration at DC. Such a limitation is a not unimportant aspect, taking into version both that loads of NCVTs and NCCTs allow the measurement of DC gears and in the new Smart Grid circumstances, with colossal incidence of scattered energy creation from renewable sources and switching power converters, the importance in the measurement of DC workings is increasing.

III COMPARATOR TO BE PROJECTED

Authors have projected a low cost ltage signals in the range of (−10 to 10) V and signals with only two mystical components are measured. Moreover, no one of the cited papers shows absolute narrative of quantity method and a full presentation characterization. Therefore, in the following a complete portrayal of the engaged hardware, the realized measurement software and a complete routine logging, counting ambiguity valuation, is existing comparator for its use to calibrate medium voltage CVT in [33]–[35]. Nevertheless: a) In only calibration in sinusoidal conditions is painstaking; b) In only calibration of current transducers with low efficiency current in sinusoidal surroundings is accounted in it.

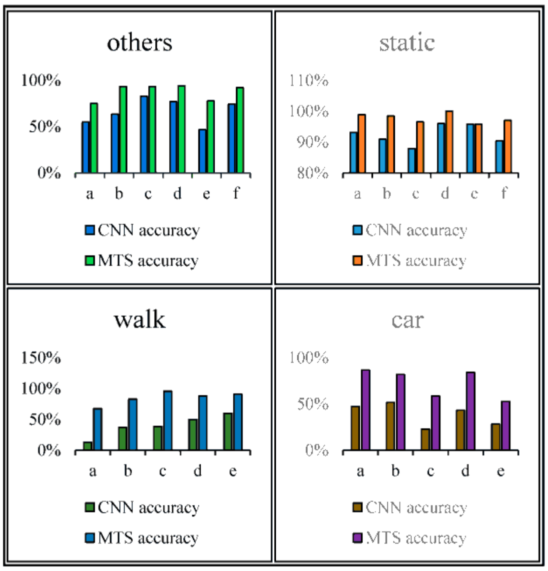

FIG. 2. **SENSORS COMPARATOR**

A. MANAGEMENT OF HARDWARE

Exciting into adaptation that the want of the paper is to understand a low cost comparator to be effortlessly and conveniently employedin laboratories of engineering companies, only all-purpose purpose measuring hardware is used. The system is together by general Instruments data awareness tools; in particular an Ethernet connected chassis DAQ 9188-XT [36] is used. a) 24 bit resolution; b) inputrange ±14 peak; c) 50 kHz highest sampling frequency;d) anti-aliasing filter with cut-off frequency equal to half of sample occurrence. The second one is NI 9225 [38], which has three disparity voltage input channels with: a) 24 bitresolution; b) ±425 summit input range; c) 50 kHz sampling frequency; d) anti-aliasing filter with cut-off occurrence equalto half of sample regularity. The third DAQ is NI 9239 [39],which has four differential voltage input channels with :a) 24 bit resolution; b) ±10 peak input range; c) 50 kHzsampling regularity d) anti-aliasing filter with cut-off occurrence equal to half of sampling frequency.

B. MEASUREMENT METHOD

The classification is able to conclude the complex frequency response (magnitude and phase error) of the sensor undertest by assessment with a situation one, with the sameapplied voltage/current, by acquiring and analysing their two output signals. These signals are asynchronously sampled at a fixed frequency (50 kHz if NI 9225, 9227 or 9239 used, while 1 MHz if only 9223 is considered). Under the hypothesis of twisted applied voltage/currentthe comparator input signals are expressed as the sum of Nsinusoidal components.So, let us consider one of the input signals, can be written as:

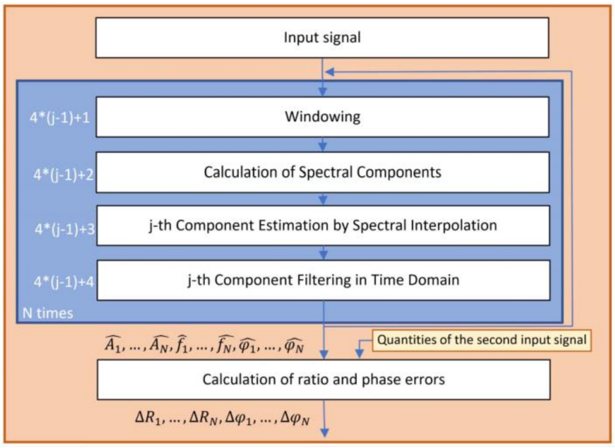

Fig. 3 Flow-chart of the desynchronized processing technique.

In a particular case, where all the components j = 2, N are harmonics of the fundamental tone, that is the ratios of f_j to f_1 are integer numbers, it is promising to attain exact values for A_1, f_1, ϕ_1 and with a synchronized supernatural breakdown, that is a time window exactly synchronized with elementary frequency should be processed by Discrete Fourier Transform (DFT).

IV. TEAM FOR COMPARATOR CALIBRATION

Complete experimental commotion has been conducted to evaluate the performance of the realized comparator. The routine has been evaluated in sinusoidal and non-sinusoidalconditions, with two different experimental setups. The first experimental setup has been used at INRIM to testthe comparator in sinusoidal conditions, while the second one, available at the University of Company, has approved the evaluation of its performance in non-sinusoidal surroundings. In the following, the two setups are described.

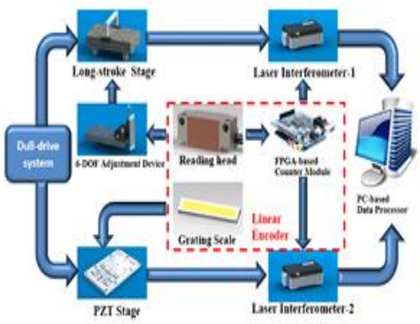

FIG. 4 CALIBRATION TEAM AND FULL PROCESS

COMPARATOR PROCESS

Fig.3. Block diagrams of the setups for comparator calibration in sinusoidal and non-sinusoidal conditions.

With such a setup, all the combinations of voltage input channels can be accurately characterized.As regards current inputs, the electrical calibrator Fluke 5500 has been employed to supply sinusoidal current signals, with accuracy of about 0.06%.

V.REPORT OF TENTATIVE TESTS

Several untried tests have been performed in order to accurately characterize the realized comparator (hardware andsoftware) and measure its payment to the ratio and phase errors, in the current and voltage sensor calibrationprocess. If the comparator ratio and phase error are accuratelyevaluated and are stable, they can be compensated, leading to supplementary accurate calibration process. All the tests have been conducted with comparator inputsignals that reproduce actual cases occurring in sensors calibrations, when comparing the outputs of two CVT with the identical ratio or one CVT and one NCVT. In particular, the following comparisons, both in sinusoidal as well as innon-sinusoidal surroundings, have been emulated: a) two CVTs,with the same and with different ratios, 2) one CVT and oneNCVT, 3) two CCTs, with the same and with poles apart ratios,4) one CCT and one NCCT with voltage output.In the following, for sake of succinctness, only some test cases are existing. For each measurement point ten readings havebeen taken and mean value and model deviation are shown.

VI. EXAMINATION IN NON-SINUSOIDAL SURROUNDINGS

The test is performed under non-sinusoidal conditions the characterization of in progress channels is presented. A zoomof the corrected phase error is also provided.Signal composed by two spectral tones are considered, essential tone, with fixed frequency of 50 Hz and aharmonic tone, with amplitude (AH) equal to 10 %, 20 %and 30 % of fundamental tone (AF), and frequency range from 100 Hz to 5 kHz. Then, for each harmonic frequency, ratio and phase errors are evaluated at the fundamental frequency (which in the various tests remains constantat 50 Hz) and at the harmonic frequency.

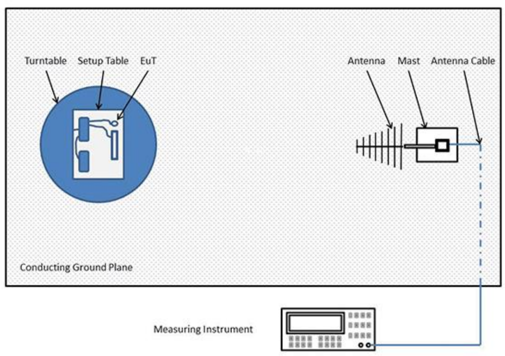

FIG.5 ANTENNA PARAMETERS

VII. ACCURACIES OF THE REALIZED COMPARATOR

The choral ratio mistake does not show a monotonic performance, and its greatest value is lower than 400µV/V. The monotonic behaviour of phase error could be due to a more marked difference in triggerdelays and in cut-off frequencies filters, since now two DAQs are used; as they are systematic effects, they can be compensated. The results of the experimental characterization of thecomparator are summarized in Table I, where accuracies for the type of sensor (i.e. voltage or current) and for the operating condition (i.e. power frequency, sinusoidal and non-sinusoidalconditions) are shown.

VIII. CALIBRATION OF A CCT

The aim of this last test was to prove the reliability of therealized system, performing the calibration of the same sensorwith two different systems: the INRIM reference test systemand the realized comparator. The chosen transducer is the CCTCROTTI et al.: INDUSTRIAL COMPARATOR FOR SMART GRID SENSOR CALIBRATION 7791

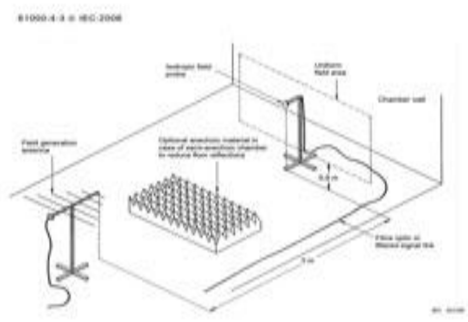

FIG.6 **NOSINUSOIDALSURROUNDINGS ATECROP**

IX. ADVANTAGES:

1. Digital/connected factory.
2. Facility management.
3. Production flow monitoring.
4. Inventory management.
5. Plant safety and security.
6. Quality control.
7. In the industrial calibration instrument being tested is compared to a known reference value at the simple level.
8. The piece of equipment or device with the known or assigned accuracy was performed in the industrial calibration.
9. Calibration is often regarded as including the process of adjusting the output or indication on a measurement instrument or to agree with value of the applied standard

X. CONCLUSION

A new industrial comparator for smart grid sensor calibration is presented. It is composed of commercial low costgeneral purpose data acquisition hardware; the measurementsoftware makes use of an asynchronous digital signal processing technique which eliminates the necessity of externalsynchronization devices. An intensive experimental characterization, with reference grade instrumentation, has beenexecuted to evaluate its performance both in sinusoidal aswell as in non-sinusoidal conditions: it results that it canbe employed in the calibration of class 0.1 conventional andnon-conventional voltage and current sensors, in a frequencyrange from DC to 10 kHz, in sinusoidal and non-sinusoidal conditions.

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