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Calibration of Energy Meter

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Abstract: The need to control the power grid in real time has opened a new field of research, today researchers are trying to design electrical meters that are completely remote controlled, to create an advanced metering infrastructure. One of the most important processes in the field of measurement is the calibration of measuring instruments. The calibration process of the electrical meters was performed at laboratories. However, the new directives, now, require a regular test of accuracy. Nevertheless, moving each time on site to check the accuracy of a meter can be annoying. To solve this problem our contribution is to propose a new structure of a smart meter that integrates a calibration card, so that, this process is carried out remotely. To be able to calibrate the meter or test its accuracy, we have included an AC-AC converter powered by the electrical grid and that provides a stable voltage independent of the electrical grid in term of frequency and amplitude. The output voltage of the converter is used as the reference signal during calibration or accuracy testing. In this paper, we will present the structure of the calibration card, the study and dimensioning of the converter, as well as the control technique used to eliminate variations of the input voltage. At the end, we will present the results of simulations and experiments.
Keywords: Remote calibration; Calibration on site; AC-AC converter; Unipolar PWM technique; Smart meter structure.

I. INTRODUCTION

With the promotion of intelligent substation, digital energy metering system has been widely used. Digital energy meter is an important part of digital energy metering system, its accuracy would influence the metering performance of whole metering system. The structure of digital energy meter is completely different from traditional energy meter, the digital energy meter receives data from merging unit which is in accordance with IEC61850-9-2 protocol, analyses the instantaneous voltage and current sampled value, accumulates the instantaneous power and calculates the electric energy. The calibration equipment and method of traditional energy meter are no longer applicable to digital energy meter.
Brief History of Energy Meter The technique of invention was an exceedingly good nineteenth-century invention." This adage, coined by the English mathematician and logician Alfred North Whitehead (1891-1947), fully corresponds to the history of the electrical meters, which has been developed through a series of advances that have built on previous achievements and encouraged further progress.
EXAMPLE: There are 5 tube lights and they are 50 watts .all tube lights run for 1 hour there are ,6 fans and all of them are 40 watts each fan run for 2 hours. television (TV) is 150 watts and it run for 4 hours .
So tell me how much Light used by all the devices .

Given :-
5 tube lights – 50 watts – 1 hour
6 fans - 40 watts – 2 hours
1 TV - 150 watts – 4 hours
FORMULA:
WATTS= VOLTS * AMPS

II. OVERVIEW OF ENERGY METER

In our research work we realize a Smart Electrical Energy Meter (SEEM). This measurement instrument is intended for the low-voltage single-phase customers. Currently the researchers develop this kind of instrument to be totally remote controlled, because of the increasing of customers and the need of the real-time monitoring. During the study, we deduced that the calibration step is one of important steps either during manufacturing or during maintenance. Moreover, this step should be performed on site and remotely for these reasons: • The calibration on site takes into account the electromagnetic perturbations. • The accuracy check of the meters will be performed without having moving a team. • During maintenance, if the meter was broken, we do not need to take it to the laboratory, for the calibration. When we want to perform the meter calibration, we need, at that moment, to know how much is the value of the electrical measured quantities (current and voltage). However, the voltage of the electrical grid can vary. For example in Morocco, the voltage can vary between 80% and 115% of the nominal value. Therefore, we cannot use this power source as reference.

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Furthermore with a basic structure of a digital meter we cannot perform the meter calibration because this instrument is connected directly, trough sensors, to the electrical grid. So, we developed a new meter structure and we added a calibration card into the meter to perform the calibration process on site and remotely.

III. LITERATURE REVIEW

Devaliya, Vishal A novel concept of a voltmeter will be introduced, in which the location of a client's greatest demand for electricity will be indicated in the meter used by the consumer. With the help of an embedded device installed in the meter, the measurements and, as a result, the connection will be robotically severed after surpassing the maximum demand. The GSM MODULE SIM 300 is used to communicate between the load circuit and the utility side. To connect it, we simply used the max232 protocol and a DB9 connector. N.W.J. Hazelton's Instrument Calibration for the Twenty┐ First Century This work provides a brief introduction of surveying instrument calibration in general before moving on to concept calibration in particular. The need for calibration is explained, as well as a quick look at available facilities. A description of what is needed to calibrate one-of-a-kind types of instruments is presented. Approach to energy meter calibration for dimensioning and verification Surma Yadav Alli, Herman Providing the highest level, Xiao Hua Xia Applied power, vol. 188, no. 5, pp. 563- 575, 2017. For usage in Measurement and Verification (M and V) projects, energy meter must be calibrated. Calibration, on the other hand, can be excessively expensive and have a detrimental impact on challenge feasibility. This study presents a revolutionary low-cost in-situ meter calibration method based on the use of a calibrator that has an extremely low accuracy commercial power meter. The simulation Causal inference (SIMEX) Measurement Error Model and Bayesian regression are used to finish the calibration process. The mannequin is trained or calibrated for 24 hours on half-hourly building electricity data.

IV. CALIBRATION METHOD

The digital power source outputs IEC61850-9-2 packets and high frequency electrical energy pulse which is used as the standard electric energy pulse. The calibrated digital energy meter receives the data packets through the network switch and outputs the electric energy pulse to the error calculation module which obtains the energy measurement error of the meter by comparing the standard energy pulse and the calibrated energy pulse. The calibration principal diagram is shown in Fig. 2. Digital Power Source Network Switch Calibrated Digital Energy Meter Error Calculation Figure 1:

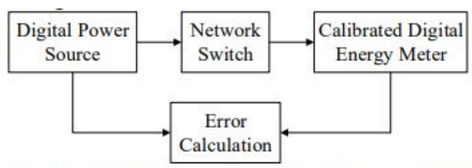

Figure 2: Standard digital power source method

In the standard digital power source method, the error calculation module calculates energy measurement error of the meter according to the standard energy pulse and the calibrated energy pulse, and the principle of error calculation is the same as that of the standard energy meter method. 2.3 Watt-Second Method The digital power source outputs IEC61850-9-2 packets to the calibrated digital energy meter which outputs the energy pulse to the pulse acquisition module and the timing module, we can calculate the time t that the calibrated meter outputs m0 energy pulses required can be calculated. The electric power generated by the digital power source in time t is converted to m virtual standard electric energy pulses of the meter. The error calculation module obtains the energy measurement error of the meter by comparing the virtual standard electric energy pulse and the calibrated electric energy pulse. The calibration principal diagram is shown in Fig. 2.

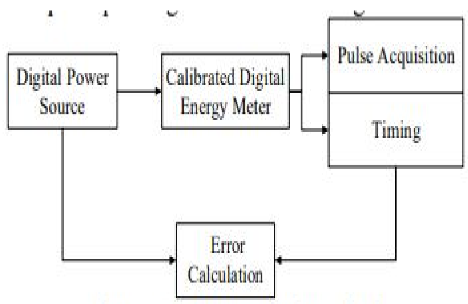

Figure 3: Watt-second method

V. PROMBLEM STATEMENT

As previously said, digital energy meters have various advantages, but there is always the possibility of innovation or change in different devices for customer and provider convenience. Meter reading and other associated tasks, like as bill payment, are handled by a large number of people.

VI. METHODOLOGY

The meter's driving mechanism is made up of two electromagnets. Steel laminations make up the core of these electromagnets. The load current excites the coil of one of the electromagnets is collage as current coil. Because the coil of the second electromagnet is connected across the supply voltage, it carries a current proportionate to it. This coil is known as pressure coil. As a result, the two types of electromagnets are referred to as series and shunt magnets, respectively. On the middle limb, copper shading bands are supplied.

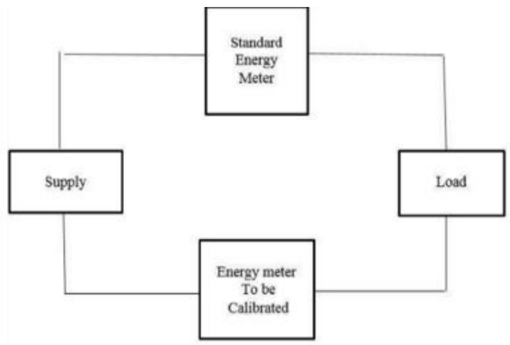

Fig. 1. Calibration of Single-Phase Energy Meter

For the watt-seconds method, its source of error is measurement time interval error, overflow error and non-full period sampling error. To improve the efficiency, we can increase the accuracy of the measurement interval with high-frequency pulse for the time counting, and the fixed pulse counting method is changed to the fixed time range to detecting the pulse number and pulse time interval, so that the working condition interference can be avoided. It applies to three-phase symmetric conditions. For the standard digital meter method, its source of error is overflow error and sync pulse error. To improve the efficiency of calibration, interpolation can be used for standard meter to improve the pulse output frequency. Energy meter with larger pulse frequency constant can be used as standard energy meter. Its applicable condition is rated conditions with larger load current. For the standard digital source method, its source of error is overflow error, synchronization pulse error and introduction error of standard digital power source. To improve the efficiency, we can increase the frequency of the pulse according to the actual working condition, and in the three-phase symmetry test, the average power method is used. Its applicable condition is rated conditions with larger load current For the standard analog meter method, its source of error is overflow error and synchronization pulse error and error caused by A/D conversion and other signal debug module. To improve the efficiency, we can select the analog standard meter with smaller error for comparison and reduce the system error form A/D conversion, signal conditioning and protocol group frame. It can be used in the requirement for traceability. The principle of standard digital source method is basically the same as the standard digital meter method, so the introduction error of each is the same. Since the standard digital source method can adjust the pulse frequency constant, the standard digital source method is more efficient. Standard analog meter method is a mature method of calibration system, but because it contains modules of the introduction of error, in general, it is inferior to digital power source method. Watt-second method introduced a new non-integer period sampling error, in the case of single-phase meter calibration, Watt-second method required a longer time. Therefore, Watt-second method is most suitable for calibration in three-phase symmetrical working condition.

VII. CALIBRATION PLATFORM

According to the calibrate method proposed in this paper to build a digital energy meter calibration platform, calibration device mainly includes digital power source and standard digital energy meter. 5.1 Digital Power Source The standard digital power source is controlled by PC. It can outputs the corresponding IEC 61850-9-2 packets according to the setting parameters. The digital power source is developed based on FPGA, it can directly calculates the data values in each frame of the sampled value according to the setting parameters. What's more, its error is smaller than the traditional digital power source that based on look-up table method.

By verification of the China Institute of Metrology, the relative error of the digital power source's output is less than 0.01%. 5.2 Standard Digital Energy Meter Standard digital energy meter uses the standard digital power algorithm embedded in PC. The computer can run a variety of power algorithms at the same time. The standard digital energy meter contains four standard power algorithms including dot-product-summation algorithm, FFT algorithm, complex Simpson algorithm and complex Cotes algorithm

VIII. FUTURE SCOPE

The proposed technology could be used as prepaid energy meter in the future. These meters can be recharged according to the needs of the user, avoiding any excess billing costs. This model employs the usage of energy meter testing to determine the actual error and reduce it. This project is extremely beneficial to consumers who are experiencing meter reading issues or any other technical issues

IX. CONCLUSION

In this paper, the existing calibration methods for digital energy meter is analyzed. In view of the low speed, the imperfect traceability chain and other problems of existing methods, "watt-Second & Standard Digital Energy Meter method" is proposed, which can calibrate the digital energy meters accurately and quickly. According to the method, the calibration platform is built and several different brands of meters are calibrated, whose results are compared with the calibration results of "standard digital power source method". Finally, it is proved that " watt-Second & Standard Digital Energy Meter method " can calibrate digital energy meter rapidly. On the other side, the structure of the calibration platform is simple so that it is of high promotion value.

X. ACKNOWLEDGMENT

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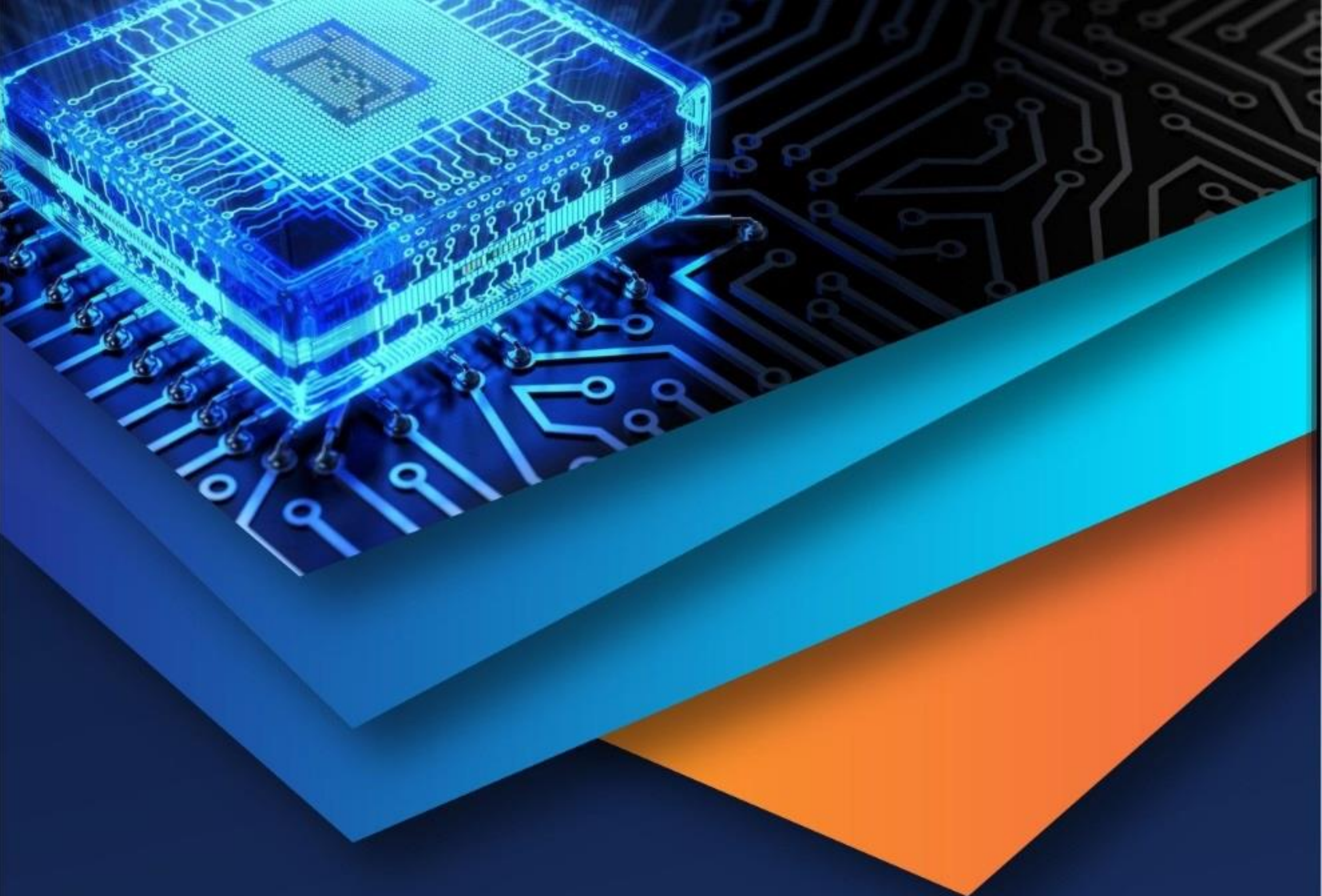

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