23rd IMEKO TC4 International Symposium
Electrical & Electronic Measurements Promote Industry 4.0
September 17-20, 2019，Xi'an, China

No oscillator output frequency counter automatic test equipment

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***Abstract* –Frequency counter is an instrument for measuring frequency signal. According to whether the internal crystal oscillator is output or not, it can be divided into the oscillator output frequency counter and no oscillator output frequency counter. For the detection of non crystal oscillator output frequency counter, manual verification method is time-consuming and laborious. In order to realize automatic operation and improving the quality and the efficiency of verification, a research on design of the automatic system is carried out. On the basis of verification regulation, a automatic test equipment of no oscillator output frequency counter is designed, which can achieve automatic verification of the boot feature, frequency reproducibility and accurate frequency.**

Keywords –Crystal Oscillator Frequency counter Automatic verification

I. INTRODUCTION

Frequency counter is an instrument for measuring frequency signal. According to whether the internal crystal oscillator is output or not, it can be divided into the oscillator output frequency counter and no oscillator output frequency counter. The no oscillator output frequency counter is widely used in production, laboratory, radio testing and other fields because of its reasonable price and simple operation.

II. RELATED RESULTS IN THE LITERATURE

For the detection of no oscillator output frequency counter, most measuring and testing institutions in China adopt manual verification method. Taking the detection of boot feature as an example, it requires the tester to continuously measure for 8 hours and record the data every hour. Such a detection process is time consuming, and labor inefficient. Therefore, it is urgent to find new detection methods to realize the automatic detection of the output frequency counter without crystal oscillator, which has far-reaching significance in saving resources and liberating manpower.

III. DESCRIPTION OF THE METHOD

According to *JJG180-2002 crystal oscillator inside the electrical measuring instrument*, no oscillator output frequency counter is calibrated on boot feature, frequency reproducibility and frequency accuracy.

The boot feature of frequency counter can be regarded as the maximum difference in the relative average frequency deviation within 8 hours of boot, and it needs to be measured continuously for 8 hours.

Frequency reproducibility is the consistency between the frequency value and the last shutdown frequency value after the frequency standard works for a period of time and the next turn-on reaches stability.

Frequency accuracy refers to the accuracy of the relative frequency deviation, measured three times in a row, and taken the arithmetic mean.

In this paper, an automatic verification device of no oscillator output frequency counter is designed，which can collect the measurement data by video system, recognize the image by computer program, calculate the corresponding performance index according to the data processed and realize automatic verification of frequency counter. The following is the system structure diagram. First, the standard frequency source outputs the standard frequency to the detected frequency counter. After the measurement, the frequency counter can display the corresponding frequency value. The screen of the frequency meter is facing the camera, and the camera shoots the picture of the frequency display screen according to the set time. The picture is transmitted to the computer program through the camera transmission line for picture recognition, data conversion, and the converted data is then calculated according to the verification procedure, and the corresponding performance index is obtained. These indicators can be

used to evaluate the quality and performance of the frequency meter being tested.

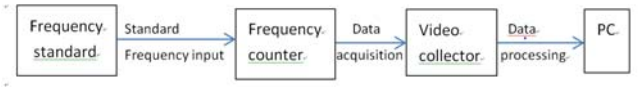

Fig. 1. System structure diagram

A. Verification of Boot Feature

(I) Input the standard frequency, adjust the measuring range and gate time of the detected frequency, and make its output stable frequency.

(II) Using the camera to collect data, it is required to collect three frequency values every hour for 7 hours. The order is as follows $(f_1, f_2, f_3, f_4, \ldots\ldots f_{21})$.

(III) Data recognition of the collected pictures. The data collected by the camera exists in the form of pictures, which need to be recognized and converted into data.This Section gives scope for explaining the used methods and algorithms.

(IV) Processing data in four steps ：

I) Perform frequency offset calculation for each value of the frequency measurement with equation (1)

$$y_i(\tau) = \frac{|f_i - f_0|}{f_0} \quad (1)$$

get $(y_1, y_2, y_3, y_4, \ldots\ldots y_{21})$；

II) Calculate the arithmetic mean every three groups in order with equation (2)

$$\bar{y} = \frac{y_i + y_{i+1} + y_{i+2}}{3} \quad (2)$$

get $\bar{y}_1 \sim \bar{y}_7$；

III) Automatic identification of maximum $\bar{y}_{\max}$ and minimum $\bar{y}_{\min}$ values by program;

IV) Calculating the boot feature of the frequency counter with equation (3)

$$V = \bar{y}_{\max} - \bar{y}_{\min} \quad (3)$$

B. Verification of Frequency Reproducibility

(I) Input the standard frequency, adjust the measuring range and gate time of the detected frequency, and make its output stable frequency.

(II) Using the camera to collect data, it is required to collect three frequency values (f_{22}, f_{23}, f_{24}) one hour after booting, and then shut down.

(III) Reboot 24 hours after shutdown. Repeat step (2) and collect three frequency values (f_{25}, f_{26}, f_{27}).

(IV) Data recognition of the collected pictures.

(V) Processing data in three steps ：

I) Perform frequency offset calculation for each value of the frequency measurement with equation (1) and get $(y_{22}, y_{23}, \ldots\ldots y_{27})$；

II) Calculate the arithmetic mean every three groups in order with equation (2) and get $\bar{y}_8 \sim \bar{y}_9$；

III) Calculating the boot feature of the frequency counter with equation (4)

$$R = \left|\bar{y}_8(\tau) - \bar{y}_9(\tau)\right| \quad (4)$$

C. Verification of Frequency Accuracy

(I) Input the standard frequency, adjust the measuring range and gate time of the detected frequency, and make its output stable frequency.

(II) Using the camera to collect data, three frequency measurements are required one hour after preheating, in turn. The order is as follows (f_{28}, f_{29}, f_{30}).

(III) Data recognition of the collected pictures.

(IV)Processing data in two steps ：

I) Perform frequency offset calculation for each value of the frequency measurement with equation (1) and get (y_{28}, y_{29}, y_{30})；

II) Calculate the arithmetic mean with equation (2) and get the Frequency Accuracy.

IV. RESULTS AND DISCUSSIONS

During the experiment, we found some problems. The brightness difference between the images of different instruments was too large and the distribution was uneven. It was difficult to binaries the image. The different placement of the instrument would affect the reading. After hard work and experimentation, we found a way to solve the problem. Using the circular light source for machine vision can eliminate the shadow of light and dark, and increase the contrast of the instrument dial. The effect of the position of the frequency meter to be detected on the recognition can be corrected in the image pre-processing step. These problems have been well resolved.

We mainly develops an open-loop automatic measurement system, which can simultaneously realize the automatic verification of multiple frequency meters. It has far-reaching significance for saving resources and liberating manpower. It includes frequency measurement, image acquisition, image processing and data processing. The technical road map is as follows:

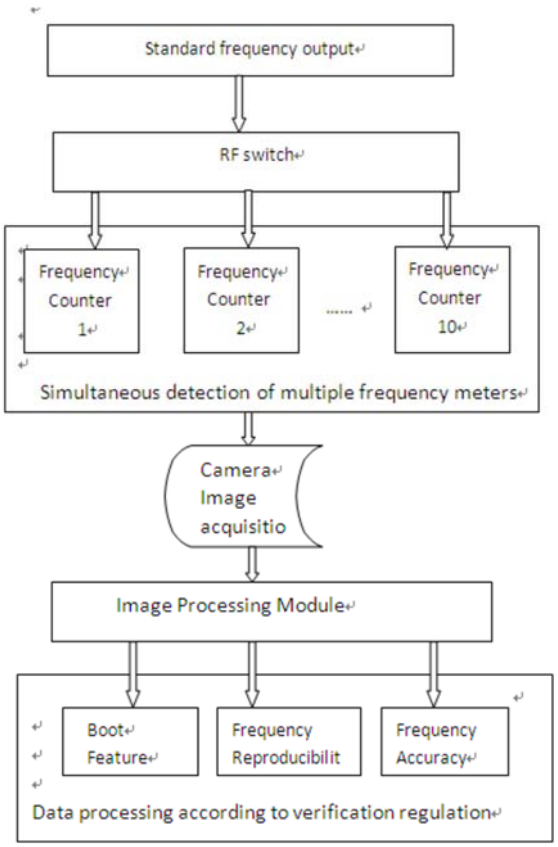

Fig. 2. Technical road map

V. CONCLUSIONS

A automatic test equipment of no oscillator output frequency counter is designed, which can achieve automatic verification of the boot feature, frequency reproducibility and accurate frequency. The automatic test equipment has the following features：

Video acquisition data, using frequency technology to directly collect and store data for frequency meter measurement data, to achieve unmanned operation.

Data identification and data processing. At present, there are few automatic detection systems in China, and only a simple camera is used for photographing. Automatic data recognition processing cannot be performed, and data is still manually recognized and processed. Our projects are able to automatically identify and process data, increasing automation and productivity.

Multiple frequency meters are detected at the same time. Through the RF switch, (1-10) frequency meters can be connected and automatically detected at the same time.

VI. ACKNOWLEDGMENT

We thank the reviewers' valuable comments and suggestions, which are valuable in improving the communication and also important for our future research.

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