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A Method for Restraining Electromagnetic Interference of Electricity Meter by Means of Pulse Width Testing Circuit

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Abstract- This paper describes a method for restraining electromagnetic interference received by reference meter clearly not caused by watt-hour meter under test by means of pulse width testing circuit. The method is adopted to resolve the problems often occurred in the type tests of watt-hour meters. During the EMC test of watt-hour meters, the tester can't confirm the additional error due to the impact of fast transient burst because the reference meter as the auxiliary instrument in the test is impacted and display the wrong percentage error. We resolve the test problem caused from the disturbance impulse coupling to the signal wires of the reference meter by means of pulse width testing circuit. The design of the impulse width testing circuit and the experiment setup are reported.

I. Introduction

IEC 62053-11:2003 [5]gives the requirment for the limits of error due to influence quantities, it demands that the additional percentage error under the fast transient burst shall not exceed 4.0 % for meters of class 1 [1]. We found severl problems in the long-term wok on EMC test. Firstly, when the fast transient burst is exerted to the watt-hour meter according to test set-up in IEC61000-4-4, the additional percentage error exceed the 4.0 % (for meters of class 1) , sometimes the percentage error is even beyond the display scope of reference meter [2]. From this phenomenan, it looks as if the watt-hour meter under test is not valid, but we found the pulse output of this watt-hour meter is regular, so we can confirm this equipment can work properly.The proble is from the reference meter being disturbed that lead to additional percentage error exceed 4.0 %. In this case, it is reasonable that the watt-hour meter is determined to be invalid equipment. Secondly, when the fast transient burst is exerted to the watt-hour meter according to test set-up in IEC61000-4-4, the reference magnetic power as auxiliary equipment is disturbed and works in disorder, for example, if it alarms, the output of voltage or current virations falls to wrong value, so that it makes the tester fail to carry on EMC test.

There are many reasons that lead to the phenomena as mentioned above. We think the main reason is that the inference signal is coupled not only to the Equipment Under Test (EUT) but also to auxiliary equipments. For the EMC test of watt-hour meters, the auxiliary equipments are the reference meter and the power source. We tested the output at the decoupling terminal of coupling/decoupling network (refer to figure 2) by means of oscillograph, the interference pulse exists and the amplitude is amount to 20 %. These interference signals disturb the proper work of the auxiliary equipment.

In order to eliminat the impact caused by the auxiliary equipment, we used several different measures. Pulse width testing Circuit is one of the measures. The basic idea is as follows. For the watt-hour meters, the accumulated ac energy is counted according to output pulse amount. Reference meter is used to compare the pulse amount received from watt-hour meter with the pulse amount produced by itself, and obtain the percentage error through comparison. For example, if watt-hour meter produces 4 pulses ,but reference meter receives 5 pulses (one of pulse caused by interference signal), the percentage error will be 25 percentage larger than real percentage error. In this condition, it is not reasonable to determine EUT is below standard. We analysed the reason why the reference meter can receive more pulses than watt-hour meter actually produced, and we think there are two possible reasons. One possibility is that the interference signal is coupled to the pulse counting in the output of EUT via coupling network circuit, and then gets into the reference meter through the connection cables. Another possibility is the path by the defective filter network which is directly superimposed to the pulse input of the reference meter. Both of the conditions will lead to the wrong pulse counting in the standard meter side. In order to eliminate this problem, the pulse width testing circuit is designed and applied to the connection between the standard electricity meter and EUT.

II. Principle for the interference restraining

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IEC standard has the regulation for the pulse width of the electricity meter [1]. The valid pulse width is 80 ms, and the variation scope for the width is within 20 ms, which gives the possibility to identify the valid pulse signal for the electricity meter. Normally frequency of the electromagnetic interference signal is higher. For example, the minimum frequency of ring wave and damped oscillation is 100 kHz, and the period is 0.01 ms [2]. A pulse width testing circuit can be introduced to reject the high frequency interference pulse. When the pulse width is above 30 ms, it is looked as the valid pulse. Otherwise, the pulse is filtered off. The pulse width testing circuit can be realized with logic circuit, so it is easier to remove the high frequency pulse interference. In addition, the amplitude of the pulse will not be influenced, and it can ensure the accurate count by the internal circuit of the standard electricity meter.

III. Pulse width testing circuit

Pulse width testing circuit is shown in Figure 1. It consists of single shot trigger CD 4098, flip and flop D generator CD 4013 and phase inverter CD 4069. The pulse output of EUT is applied to the input of the pulse width circuit.

The input pulse signal is applied to the trigger plus terminal of CD 4098 and trigger terminal of CD 4013 at the same time. The output Q- of CD 4098 is used as the clock signal of flop D generator. After the monostable finished, the Q- of CD 4098 is in rising edge of a pulse, then the input signal is introduced to the output of CD 4013. When the input changes to low level, CD 4013 is reset via the phase reversal of CD 4069. If the electromagnetic interference signal is coupled into the input, because the width of the interference signal is much less than that of the valid pulse signal, it triggers the single shot trigger as well, but the D terminal of CD 4013 has been in the low level stage since the jumping in Q- of CD 4098. The high frequency interference signal is eventually filtered off in the output.

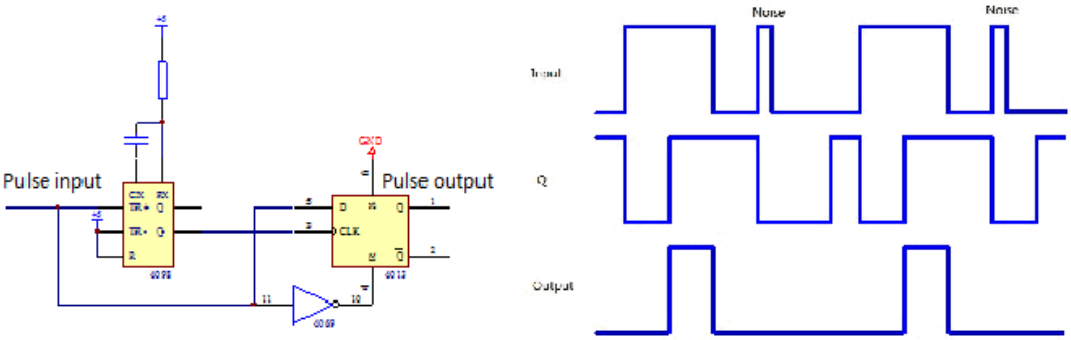

Figure 1. Pulse width testing circuit and sequence chart

IV. Test setup and results comparison

The pulse width testing circuit is introduced into the immunity test. The fast transient burst immunity test setup is shown in Figure 2. The burst generator produces the fast transient burst signal, then couples the burst signal to the EUT through coupling/decoupling network. At the same time, the immunity signal (the Fast transient burst signal) is decoupled through coupling/decoupling network. The voltage generated from the power source is applied to the EUT and reference meter through parallel connection, and the current generated from the power source is applied to the EUT and reference meter through series connection. There is a pulse width testing circuit between the pulse output of EUT and the pulse input of reference meter. If the pulse width of immunity signal measured by the pulse width testing circuit is over 30 ms, this pulse will be filtered off, otherwise it will be counted as the output pulse of EUT and compared the pulse mount with reference meter. Then the percentage errors are calculated and displayed by reference meter.

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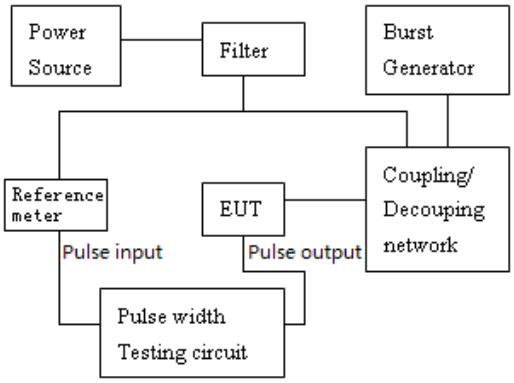

Figure 2. Electrical fast transient/burst immunity test setup

Table I

COMPARISON OF EXPERIMENTAL RESULTS OF FAST TRANSIENT BURST IMMUNITY TEST. D1 IS THE PERCENTAGE ERROR WITHOUT PULSE WIDTH TESTING CIRCUIT, AND D2 IS THE PERCENTAGE ERROR WITH THE USE OF PULSE WIDTH TESTING CIRCUIT

Inject mode	To Voltage loop		To Current loop	
	D1	D2	D1	D2
Percentage Error before Test	0.13	0.13	0.13	0.13
Percentage Error in the Test	33.5	0.21	err	0.22
Additional Percentage Error	33.4	0.08	---	0.09

Table I gives the comparison between the test results without the pulse width testing circuit and the test results with the use of the pulse width testing circuit for an watt-hour meter of class 2 under test. The voltage amplitude of interference pulse is plus/minus 4 kV and the interference pulse is coupled to EUT in common mode. Fast burst is applied to the voltage loop and current loop respectively in the test. According to the IEC standard for Class 2 alternating current watt-hour meters, the additional error should be within 2% [3] [4].

When we carry on the fast transient burst test without the pulse width testing circuit, the additional percentage error exceeds far from the limits. After we use the pulse width testing circuit and repeat the test, the additional percentage error is within the limit. The EUT finally passes the electrical fast transient/burst immunity test.
Through large quantity of tests, it is proved that the pulse width testing circuit is useful to eliminate the disturbance impulse coupling to the signal wires of the reference meter.

II. Conclusions

The pulse width testing circuit has been developed for the immunity test of the watt-hour meters. The circuit is introduced between the output of EUT and the input of the reference meter in our EMC test setup. The influence from the electromagnetic interference coupling into the pulse input terminal of the reference meter is effectively eliminated. The pulse width testing circuit is able to solve the EMC test problem of watt-hour meter relevernt to the signal input circuit of the reference meter being disturbed.
There are many other problems in the EMC test of watt-hour meters such as the voltage circuit or current circuit of power source being disturbed and so on. If We want resolve the EMC test problems of watt-hour test thoroughly, we must decouple the interference signal thoroughly through coupling/decoupling network. In this circumtance, if the EUT is not able to work properly, we can confirm it must be caused by the EUT itself, so the test result is a certain.
We suggest that the IEC standand should specify the parameters of the output terminal of coupling/decoupling network, which should not exceed the certains in case that the auxiliary equipment impacts the test results.

References

[1] IEC 62053-21:2003 Electricity metering equipment (a.c.) – Particular requirements –Part 21:Static meters

for active energy(classes 1 and 2).
[2] IEC61000-4-4, “Electromagnetic compatibility (EMC) - Testing and measurement techniques- Electrical fast transient/burst immunity test”.
[3] IEC 60514, Acceptance inspection of class 2 alternating-current watt-hour meters.
[4] IEC 61358, Acceptance inspection for direct connected alternating current static watt-hour meters for active energy (Class 1 and 2).
[5] IEC62053-11:2003 Electricity metering equipment (a.c.) - Particular requirements - Part 11: Electromechanical meters for active energy (classes 0.5, 1 and 2).

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