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Study in Step by Step Electric Energy Meter Connection Detection Method

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Abstract

Electric energy meter wiring error variety, detection method and circuit can only detect some kinds of wrong wiring at present, as the current transformer and current detection unit terminal short-circuit characteristics of conventional methods in existence, not take out stitches under the premise of not achieving detection. Based on this, this paper puts forward a step detection method, detection circuit of voltage and current lines one by one through right off and polarity of current, gradually show every junction point junction and the fault point. Through the Multisim software simulation, and developed a set of wire detecting device, simulation and experimental results prove that the method is correct. Compared with conventional methods, can be more comprehensive and faster connection detection fault location.

Keywords: *electric energy meter; wiring, detection, fault location, step by step*

1. Introduction

The smart grid and new energy [1-2] develop with the development of the society. The accuracy of the power of information collection equipment is one of the significant factors of fishery economy growth. The correct connection of electric energy metering device is the necessary condition to guarantee the accuracy of the electric energy meter[3], with a new type of meter and the new measuring means constantly updated, the way of power theft is developing to a more subtle and more technological trend. Thus to ensure the accuracy of electric energy meter and device is particularly important.

There are many kinds of wrong connection modes of watt-hour meter, for example, there are 287 kinds of wrong connection modes to three-phase three -components, and 575 kinds of wrong connection modes to three-phase three-wire watt-hour meter [4]. At present there are two common testing methods [5-12]. One method is to detect each of the lines item by item, when there is no electricity and no loads for electric energy meter.However, because of the electrical interference and short circuit characteristics of the electric energy meter wiring circuit, the only way to detect the false connection is to rip out the wiring circuit. The other method to detect error-wiring is suitable for the electric energy meter having been put into use, which means there is electricity and loads for electric energy meter.This kind of method can only detect a type of wrong wiring, which are complex and are not universal. In addition, this method exist some safety problems.

Based on the disadvantages of the current methods, this paper analyzes the structure and principle of electric energy meter and proposes a novel detection method of electric energy meter. This novel method can detect all the wrong wiring in electric energy meter quickly, and there is no need to rip out the existing circuit.Besides, this method can accomplish the fault detection without electricity and loads.

2. Conventional Detection Method and Disadvantages

There are mainly two kinds of wrong wiring, first one, the wiring is not connected including poor contact and breakage. The second one is the wrong connection terminal, such as terminal dislocation and reverse polarity. For general wiring error, we can detect the fault point by checking the unconnected terminal in turn, but if there is any short circuit, as shown in Figure 1, if a+ terminal and a- terminal are in short circuited state, on the premise of not removing

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stitch, it unable to detect the wrong wiring by measuring in the state of on and off. The positive and negative terminals of current transformer, the positive and negative terminals of current test unit are in short circuited state.

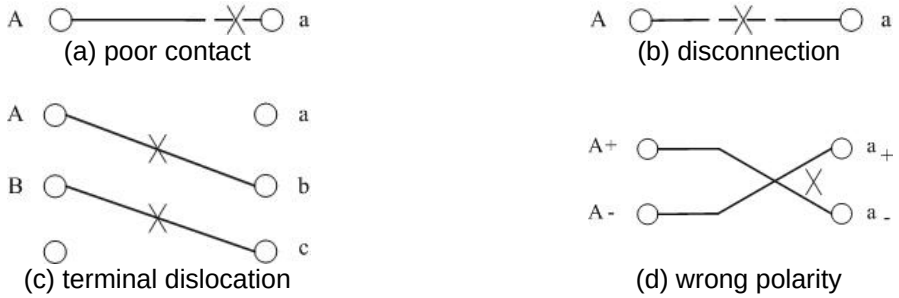

Figure 1. Common terminal error types

There are lots of electric energy meter device wiring errors including terminal short circuit, so on the premise of not removing stitch, these errors bring certain difficulty to detection, chose the process of three-phrase four-wire accessed by current transformer and voltage transformer to introduce. As shown in Figure 2 there are 10 routes between two terminals about 3.62 million kinds of attachment, but only the one which is shown in the picture is correct. In summary, the way of conventional detecting is screening each route, detecting the electrical relationship between terminals can complicate the process of detection, and it requires higher skill of people [13, 14]. At the same time, when there is short circuit, the detecting results can't reflect the actual state of wiring.

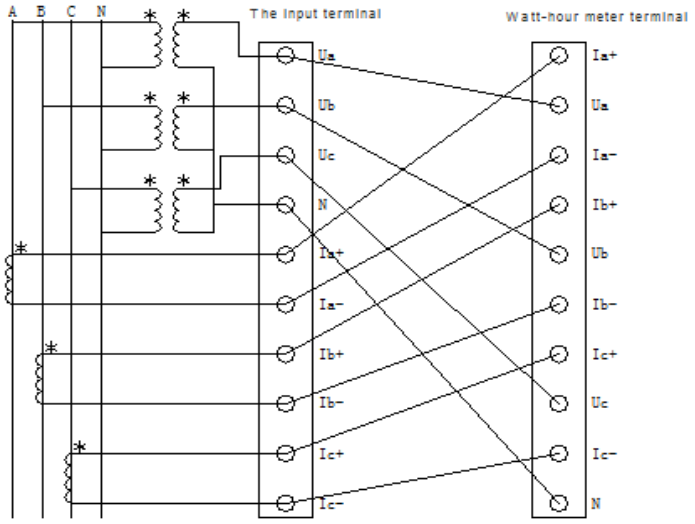

Figure 2. The correct wiring diagram of electric energy meter

3. The Principle of Stepping Type Detection

In order to solve this difficult problem, this paper uses contradiction-separation principle and puts forward that the detection process is divided into two steps. The first step, test the voltage on and off, second step, judge the current on and off. When each step is completed, detection area gradually narrowed, reduce the detect difficulty [15]. The detailed step process is shown in Figure 3.

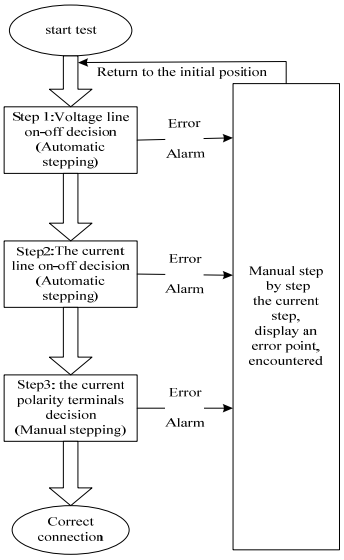

Figure 3. The flow char of incorrect connection detection

Through the above steps 1 and 2, it can detect to the common wrong connection type, through the third step determining the current terminal polarity. To make up for the pick up against the wrong type of polarity, eventually achieve the goal of complete detection.

3.1. The First and Second Step On and Off

For on-off test connection, adopt the automatic stepping mode, improve the efficiency of detection, it's principle is, test whether the terminal of current and terminal of voltage are connected, display and compare the test results through the LED, if correct, step to the next terminal test automatically, and so on, if there is any fault point, output alarm signal, and step into the manual cycle model, through the indicator light, display fault point clearly. After the check and troubleshooting, the program returns to the initial state for testing again, if the connection is correct, output the signal of right wiring [15-22]. The corresponding testing steps detection area and the attachment are shown in Figure 4, different covers can be seen from the diagram, each region and each wire connection points, had been achieved in theory blind spot detection.

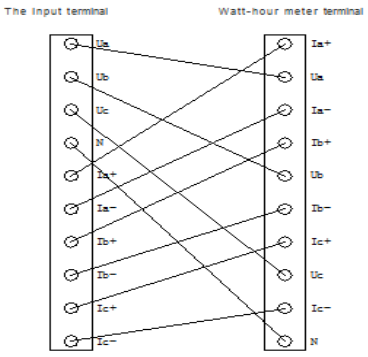

Figure 4. Step 1 and step 2 test terminal and the attachment relations

Concrete realization principle is shown in Figure 5, the test system uses 555 timer and 192 counter to produce two sets of the pulse signal which has the same frequency different width, the wide pulse generates two groups of test signal through decoder chip and test probe, one group drives the LED of sender terminal directly, another group signal drives the LED of

receiving terminal after going through the measuring terminal. Compare the two sets of LED lights, the fault point and the test process can be displayed clearly, at the same time, the synchronous narrow pulse control alarm circuit gives the corresponding control signal, realizes switching between automatic alarm and manual alarm.

For example, first output a wide pulse, and output 00000001 after counting and decoding, divided into two groups, one group lights up the LED Ua, the rest LED lights of the sender are not bright which means now is detecting the connection of Ua terminal, another group lights up the LED after going through the input and output of the terminal under test, if the connection is correct, the receiver Ua will be lighted up. The system will output 00000010 after counting and decoding when the second pulse comes automatically to test the Ub terminal. If all the receiving LED are not lighted which means disconnection or poor contact, the output fault signal changes to manual reroute model, if Ub is lighted, it means Ua and Ub is connected, the output alarm signal changes to manual reroute model. In manual reroute model, signal is not produced by 555 but the switch signal and artificial button.

Synchronous narrow pulse: Because there may be some delay when the two testing signal jump, so as to prevent the alarm module miscalculation, use the narrow pulse to filter detection signal, namely only chose the middle part of the stable signal for testing and alarming.

Alarm module: The two signals input to the alarm module, if they are the same, it means right, otherwise means wrong and alarm. The alarm signal outputs only when narrow pulse is high level, it lights the alarm LED and prompts changing lines and cuts off the output signal of 555 then access the artificial input pulse into the manual model.

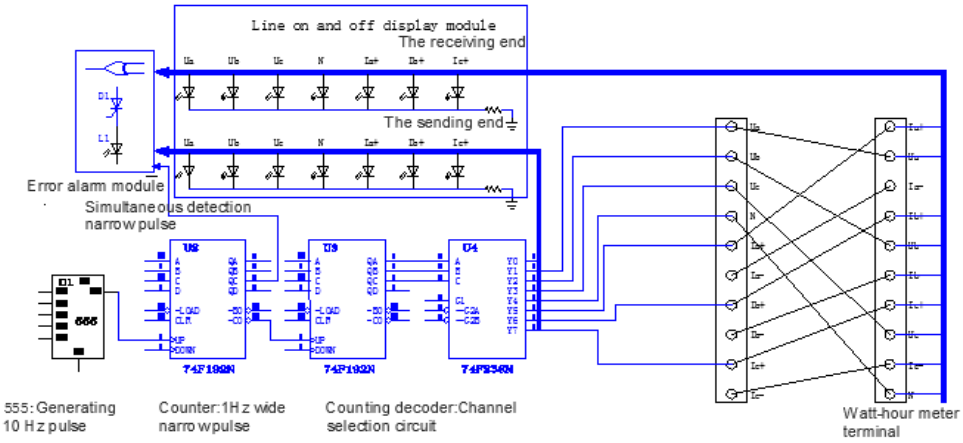

Figure 5. Voltage current detection circuit

3.2. Current Terminal Polarity Judgment

Current terminal determine polarity detection area is shown in Figure 6.

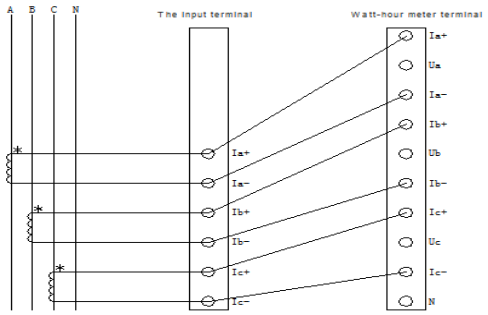

Figure 6. Polarity detection area in step 3

The test principle is shown in Figure 7, using crrent loop decision method to determine, input test DC signal on both ends of current transformer, install the current sensor in the test circuit, testing the direction of current, Op-amp and the thyristor amplify and latch the signal, if correct polarity and current direction is positive, the LED light, if the polarity is correct, current direction is positive, the LED lights, if the polarity is wrong, the current direction is negative, alarm the indicator light, manually enter the reroute model. Through three times detection, can complete the ABC three phase current terminal polarity decision, output "test is successful, trouble-free" signal after complete.

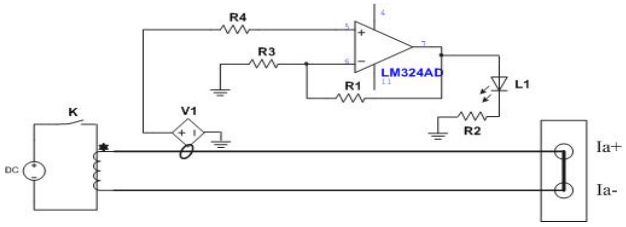

Figure 7. Current terminal polarity judgment

4. The Simulation and Experiment

4.1. The Simulation Verification

Multisim simulation shows that the test circuit can effectively detect such problems as the disconnection, wiring and wrong polarity, etc, and can realize fault location and fault alarm very well. Fig.8 is the third step simulation screenshots.

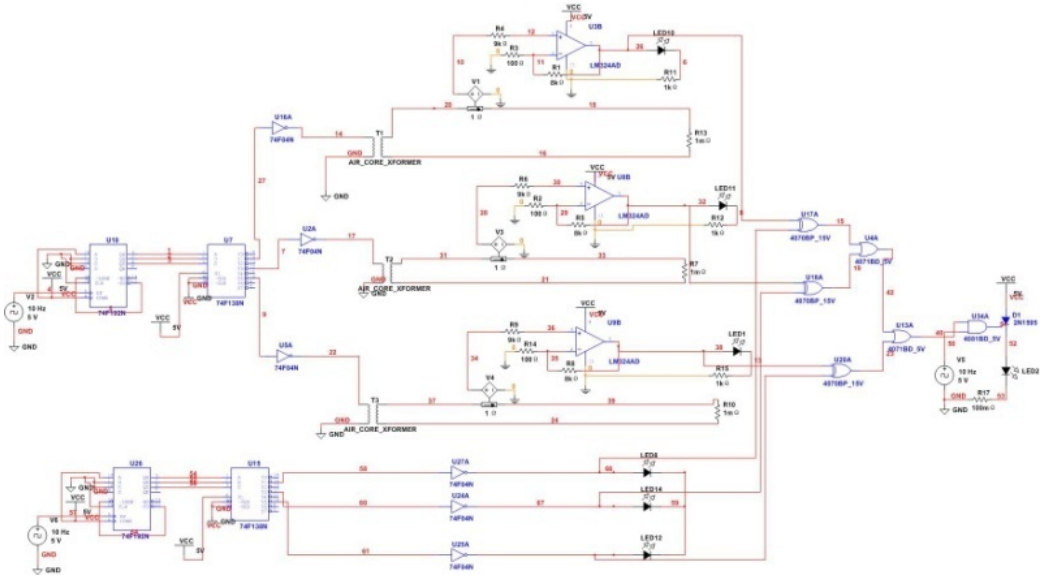

Figure 8. The simulation screenshots in step 3

4.2. The Experimental Prototype Verification

After the completion of electric energy metering device wiring detector, in six local power supply companies and other units for electric energy metering device wiring inspections and compared with conventional detection methods in detection accuracy and time.

Table 1. Accuracy comparison table after using the new type instrument

Validation company	Multimeter accuracy（%）	Experience to judge accuracy（%）	Accuracy of new instrument （%）
NA company	90	50	100
JB company	80	40	100
WZ company	Unused	40	100
TL company	Unused	30	100
BB company	Unused	20	100
DJ company	Unused	30	100

As shown in Table 1, each unit of the employees in after the completion of the installation of electric energy metering device, with a new type of instrument wiring check accuracy reached 100%, intermediate and above staff members are able to operate properly.

Table 2. Time comparison table after using the new type instrument

Validation company	Multimeter （Min）	Experience to judge （Min）	New instrument （Min）
NA company	25	10	<4
JB company	25	12	<4
WZ company	30	15	<5
TL company	35	15	<4
BB company	30	14	<5
DJ company	35	15	<5

As shown in Table 2, the time shortened to average less than 5 minutes after using the new instruments to determine.

5. Conclusion

The step test in this paper, it's main contribution is:

1) Simplifies the process of electric energy metering device wiring detection effectively, realizes the fault accurate positioning, improves the detection efficiency and reduces the dependence on testing staff skills. By analyzing the connection test difficulty, puts forward the current loop direction decision to implement the polarity decision, without stitch line, make up for the disadvantages of the conventional method can't detect such failure. Simulation and experimental prototype data show that this method is aimed at all kinds of common errors wiring detection and d the accuracy was 100%, the testing time is shorten by 5 minutes compared with the common method.

2) This method can accomplish the fault detection without electricity and loads, which can reduce the safty potential when there is some fault connection existing in the circuit.

3) Step test is successfully and effectively used in electric energy metering device wiring tests, and has the certain theory reference significance to other electronic power equipment in wiring detection the precondition of no power or no removing stitches.

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