Design of the automatic warning device for running generator

Van Nam Bach, Duy Khanh Pham, Tuyet Hoa Thi Nguyen

Abstract— **In this paper, the automatic warning devices for running generators in telecommunication stations are designed and implemented. These devices can be used for two cases: the generator is located inside Base Transceiver Station (BTS) and the generator is located far away from the BTS. These products have high applicabilities and competitive pricing. They are applied at BTSs of MobiFone Vietnamese telecom company.**

Index Terms— **BTS, MobiFone, generator, warning device.**

I. INTRODUCTION

The BTSs of MobiFone Vietnamese telecom company are using 3 power sources: Electrical grid, standby power supply (SPS) and generator. However, power grid outages are still frequent, especially in the summer [4]. When the power grid outage occurs, the BTS works with the SPS which has the working voltage range (48 ÷ 54)VDC, and the working time ranges (2 ÷ 8) hours, depending on the battery capacity. When the battery of SPS is exhausted, we have to let the standby generator work to maintain the continuous operation of the BTS.

The standby generator can be located inside the station or far away from the BTS. The operation of generators in BTSs of MobiFone Vietnamese telecom company depended on the technical staffs who calculated the running time of the generator and fuel consumption for BTSs. Thus, this was not fully automated and sometimes, it also caused the fraud in the calculation of fuel consumption.

There were several methods already applied in the reality to solve this problem, and one of the most popular solutions is the remote monitoring and warning system for BTS [1],[2]. This solution requires the internet connection or mobile data (via modulsim). However, BTS stations of Mobifone Vietnamese telecom company do not have the internet connection and the modulsim plan. Besides, the management of the sim card is complex becaus the regulation of sim card which will be recalled after 60 days do not arise expenses [3]. In this paper, the authors propose two solutions to be able to alert the generator to prevent fraud in calculating fuel consumption based on the available infrastructure of BTS. These solutions have been implemented in BTSs of Mobifone Vietnamese telecom company.

II. SURVEY PROBLEMS

Figure 1 describes a basic structure of a BTS which includes information processing equipment and auxiliary devices. The information processing equipment includes: Antenna mast, antenna, feeder, BTS cabinet. Auxiliary devices to support the continuous working process of the station, it includes: AC grid, battery, generator, air conditioner, sensors (fire alarm sensor, intrusion sensor), water sensor, etc), siren, lighting system, lightning protection system.

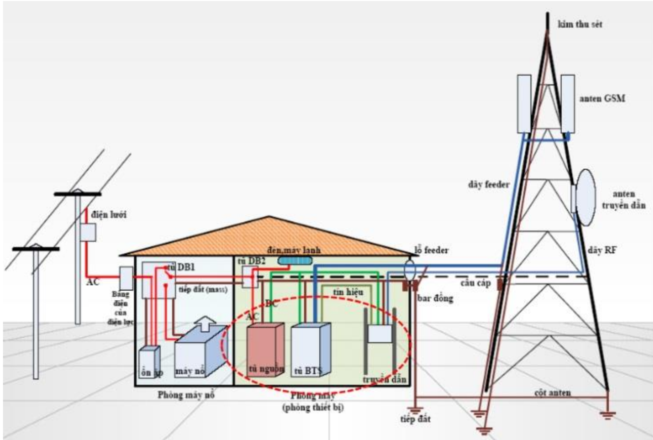

Fig. 1: Basic configuration of Base Transceiver Station

In each BTS cabinet, there are warning cards, warning signals are played on this warning card with the working principle: Circuit closure is non-warning, open circuit is warning. These warning signals are sent by SMS to the technical staffs via the internal switchboard.

Power supply system of a BTS includes: AC grid, battery (usually 3 batteries placed in the engine room) and generator. In plain areas, the generator is often located inside BTS (Figure 2), and in high mountainous areas, the generator is located far away from the BTS. In this case, BTS is usually located near to mountain peaks while the generator is usually placed at the foot of the mountain along with the circuit breaker to operate easily when the power grid outage, therefore the distance is quite far (500 ÷ 1000)m (Figure 3). Thus, we need two design methods that are suitable for each case.

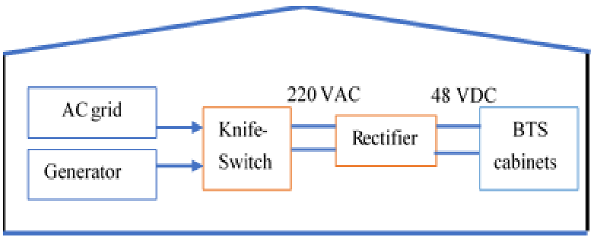

Fig. 2: Generator is located inside BTS

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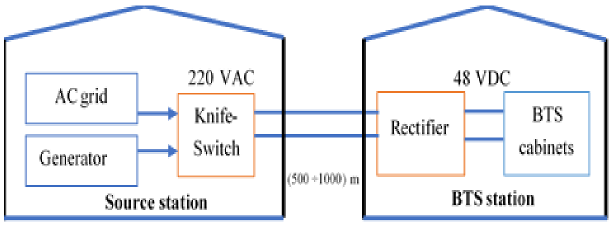

Fig. 3: Generator is located far away from the BTS

III. DESIGN OF WARNING DEVICE FOR RUNNING GENERATOR

As mentioned above, there are 2 cases of placing generators, it depends on the location of the BTS installation. In this paper, there are two sets of warning devices for running generators corresponding to these cases with the competitive pricing.

The basic working principle of device is: When the generator works, the device detects and sends a warning signal to the warning card (in the BTS), if the generator stops working then these one deletes the warning. Based on the time of the working/non-working of generator,we can calculate the fuel consumption correctly.

3.1 The warning device for running generator in case the generator is located inside the BTS

In this case, the generator is placed at the BTS station so the method for warning is to install directly the alarm device on the generator (Figure 4). In this diagram, the output voltage of the generator is connected to 2 source pins (pin 13 and pin 14) of Omron MY4N Relay, normally closed contact pair (pin 1, pin 9) of the relay is connected to the warning pin on the warning card (in BTS canbinets).

Fig. 4: Diagram of warning installation block

The working principle of the warning device is as follows:

- When the power grid works, the generator does not operate, there is no power to relay, the normally closed contact pair (pin 1, pin 9) remains in their state, so alarm card emits a signal which indicates "generator no working" to management department.
- When the power grid outage and battery voltage below 48VDC, the generator works, the normally closed contact pair (pin 1, pin 9) is opened and alarm card emits a warning signal.
- When the power grid is connected again, the normally closed contact pair (pin 1, pin 9) is closed and delete the warning signal.

The advantage of this method is simple installation, low cost (5.46 USD) [3] because only 01 Omron MY4N relay is needed. This device has been installed at BTSs of MobiFone Vietnamese telecom company (Figure 5).

Fig. 5: Image of installing the warning device for running generator in case the generator is located inside BTS

However, the design of this warning device is not suitable for generator which is located far away from BTS because the distance from the generator to the BTS is quite far (500 ÷ 1000) m, it causes the problems of material price (more than 500 USD). In next part, the authors present the design of warning device in case of generator is located far away from the BTS with suitable costs.

3.2 The warning device for running generator in case the generator is located far away from the BTS

In figure 3, the voltage from the power grid or generator delivered to the knife-switch then taken to the BTS, so we have a problem: how to know if the power grid or generator is connected to BTS to give a warning to run the generator.

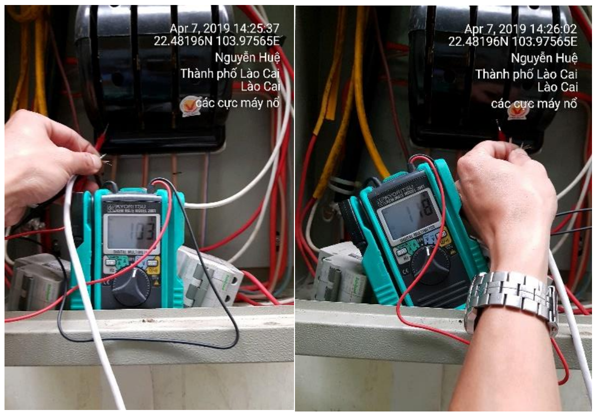

Fig. 6: The measured voltage between source poles (L and N) with earthing in case the generator is working

Using the multimeter (VAC mode) for measuring voltage between the source terminal (L and N) of the BTS (before the rectifier) compared to the earthing (Figure 6), the authors noticed:

When the power grid outage, generators is working, measuring voltage between (L or N) terminal and earthing, the measured voltage is (110 ± 10) VAC.

When the power grid works, the generator does not operate: the measured voltage between L terminal and earthing is (220 ± 10) VAC and the measured voltage between N terminal and earthing is 0 VAC.

From this difference, the authors design the measurement circuit (Figure 7), a detection circuit to distinguish between the power grid and the generator (Figure 8) and give a warning for running generator (Figure 9).

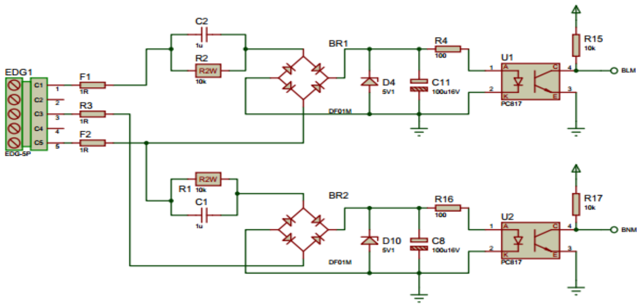

Fig. 7: The circuit diagram measures the voltage between the source terminal (L or N) and the earthing

In the circuit diagram of figure 7, the L terminal of the power source is connected to pin 1, the N terminal of the power source is connected to pin 5 and the ground is connected to the 3 pin of the hearder EDG-5P. The voltage from the L terminal and the N terminal is brought to the rectifier circuit and taken to PC817 optical isolators before being sent to the PIC16F72 microcontroller.

The generator does not work: The voltage at the two inputs of the circuit is (110 ± 10) VAC, the two outputs of the circuit (BNM and BLM) are logic 1.

The generator works: the voltage on the L terminal is (220 ± 10) VAC, the BLM output is logic 1, the voltage at the N terminal is (220 ± 10) VAC, the BNM output is logic 0.

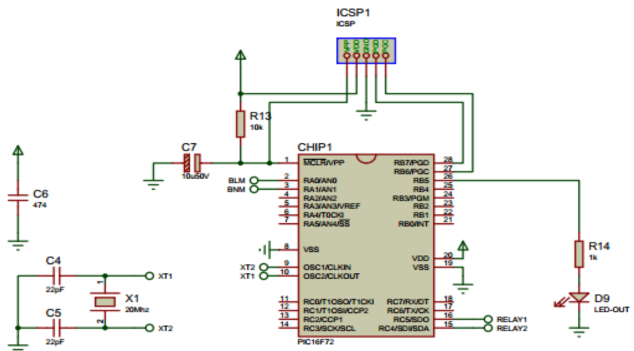

Fig. 8: Diagram of the detection circuit to distinguish between the power grid and the generator

We use PIC16F72 microcontroller in diagram of differentiated power grid or generator circuit (Figure 8).

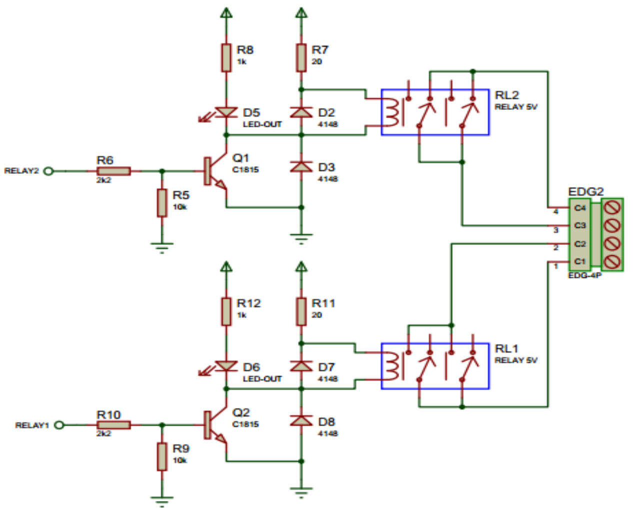

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Fig. 9: The circuit diagram sends signals for running generator or power grid to the warning card (in BTS canbinets)

The input of the circuit is the BNM and BLM signals that are connected to pin 3 and pin 2 of the microcontroller. Two outputs (pin 16 and pin 15) are brought to control the switching of Relay 1 and Relay 2 (Figure 9). The signal from the relay is sent to the EDG-4P Hearder and played on the warning card to issue reports warning power grid or running generator. The programming principle for the microcontroller circuit follows the relationship between output and input (Table 1).

Table 1

BLM	BNM	Relay 1	Relay 2	Meaning
0	0	Close	Close	The power grid outage, BTS is using battery, the generator does not work
1	0	Open	Close	Using power grid, the generator does not work
1	1	Close	Open	The power grid outage, battery voltage below 48VDC, using generator

Figure 10 shows a complete product of a warning device for running generator in case the generator is located far away from the BTS. This solution has advantages compared to the design plan in section 3.1. It does not cost to pull the wire, detection circuit to distinguish between the power grid and the generator and this warning device is installed at the BTS with its cost is about 18.5 USD.

Fig. 10: Actual image of the warning device for running generator (in case the generator is located far away from the BTS)

IV. CONCLUSION

In this paper, the description of designing and implementing of the warning device for running generator is presented. This device is installed at Mobifone telecom company. Method 1 (section 3.1) with cheap, easy-to-install product prices is installed for generators located in BTS, method 2 (section 3.2) is higher price than installation for remote generators BTS. However, the cost of this plan is still much cheaper than the plan to pull the wire from the generator to the BTS. Some BTS stations, due to bad grounding, the measured voltage between L and N terminals is not only 10 VAC so the above two methods cannot be used. This section is also the future research of the authors.

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