IMPLEMENTATION OF A METHOD TO DETECT UNAUTHORIZED TAPPING OF THE SERVICE CABLE

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ABSTRACT

Stealing of electricity is one of the major problems that power distributors and suppliers face since it directly affects to reduce their annual turnover. Such consumers and their incorrect electrical systems should be properly recognized before taking any legal action against them.

Illegal tapping of the service cable before the electricity meter is the commonest method. But identification becomes very difficult when all those cables are invisible to the investigator. At the same time many mechanisms and circuitries are also deployed simultaneously to prevent being discovered.

***U**nauthorized **T**apping **D**etector (**UTD**) will give clues whether the cable is tapped or not and where to investigate further.*

This paper presents an approach in recognizing illegal tapping. This is needed by LECO (Lanka Electricity Company), a distributor in the local electricity market. Any client who uses the electricity in secret will directly cause to reduce the profit.

1.0 INTRODUCTION

In third world countries the price of the electricity is considerably high. As a result many methods are used by the consumers to get electricity without paying the price for it.

The aim of the project is to provide an affordable solution in detecting such cable arrangement. The initial investigations carried out have helped LECO to find out many of these disagreeable-consumers. Still many more are believed to exist.

The supplier is permition to approach only up to the electricity meter in the client's premises. So checking the cable can't be done in the normal way. If the service cable is visible from the tapping at the distribution cables to the input of the electricity meter, the arrangement can be investigated with ease. When the service cable is invisible or no right to trace it back (the cable is coming through client's premises), other acceptable methodologies must be deployed.

Another important matter is that the wire arrangement used for the purpose. Initial studies have revealed many possible circuitries as shown in figure 1.

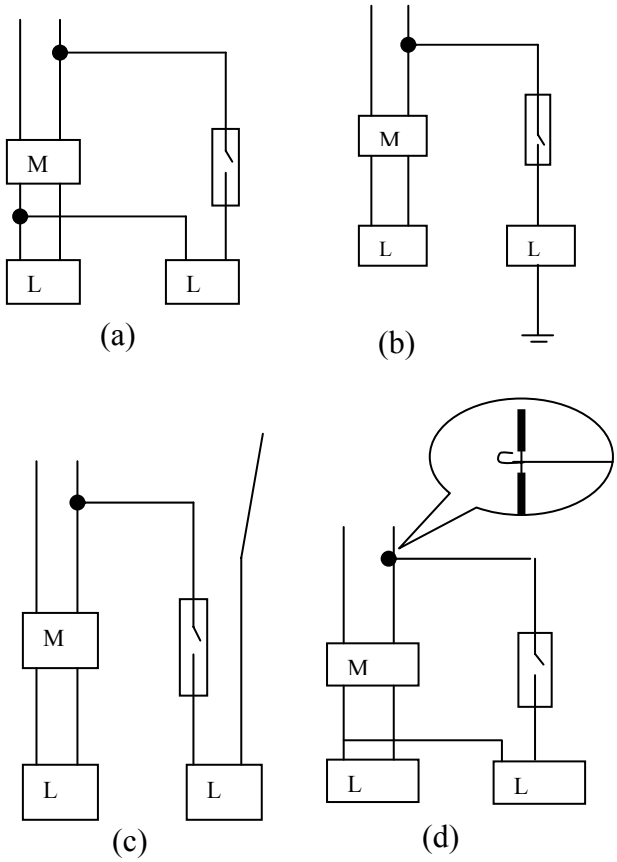

Figure 1- Some arrangement used for illegal tapping

By simplifying the above arrangements, one basic circuitry can be deduced as shown in figure 2.

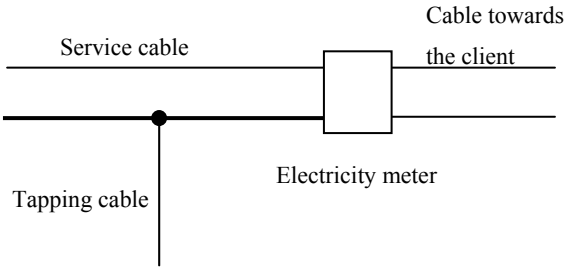

Figure 2- Common basic circuit used for illegal tapping

According to diagram the cable is tapped giving an electrical junction. This generates reflection for the signals coming down the cable. This phenomenon can be utilized in detecting such irregularities in an unreachable cable.

However the conditions and constraints given in section 2 should also be identified.

2.0 CONDITIONS AND CONSTRAINTS

The proposed methodology should be capable of recognizing such system with the following conditions and the restrictions.

- The connection between the service wire and the distribution cable can't be disconnected for the test.
- No cables can be taken out of the wall or any other shield for investigation.
- If any, connection between the service wire and the energy meter can be disconnected.
- Length of the wire may or may not be known.
- Should be a simple method.
- The specifications of the service wire are known (such as diameter and material which are needed for the calculations of propagation of a wave).

3.0 PROPOSED METHOD

Figure 3 shows the arrangement of the all units of the proposed method.

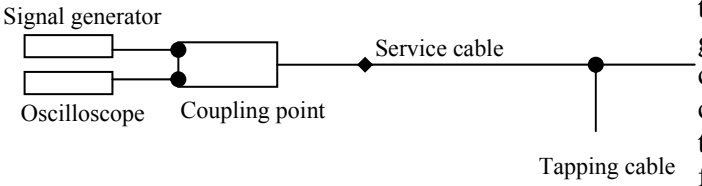

Figure 3-Proposed Method

The testing is carried out by following the steps given bellow,

- Sending a signal burst using the signal generator and connect the oscilloscope to the circuit.
- Then only the reflected wave signals can be observed by the oscilloscope.
- Time duration of the reflected wave should be analyzed.
- If there is no unauthorized tapping then the reflected wave is generated at the pole otherwise i.e. if it is unauthorized then the wave is reflected first on the tapping point and then from the pole.
- Wave reflected from the tapping point has
    - High amplitude than the wave reflecting at the pole.
    - Shorter time.

3.1 principle of operation

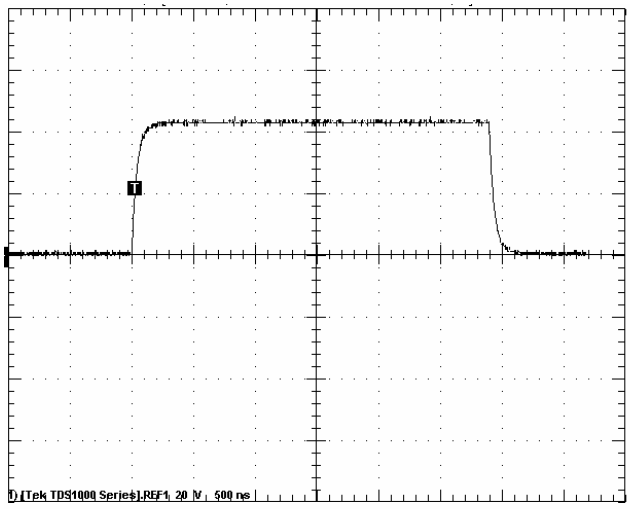

Figure 4- Undistorted waveform

The original pulse wave format injected to the system is shown in figure 4. It is approximately a square wave form with known constant frequency. When this pulse train is coupled with untapped cable, the waveform gets changed in shape as Figure 5. This is for characteristics of length 41m and impedance 50 ohms cable used for domestic consumers. The differences in the cable characteristics may result in a range of wave forms.

The frequency, duty of the pulse and amplitude must be adjusted such that an observable and clear wave pattern is displayed when the suspected system is investigated.

The modified waveform will be like shown in figure 5 the above specifications due to the many reflections occurred at the open end.

If the cable is tapped, then above pattern no longer exists, mainly due to the electrical junction present and reflections occurred.

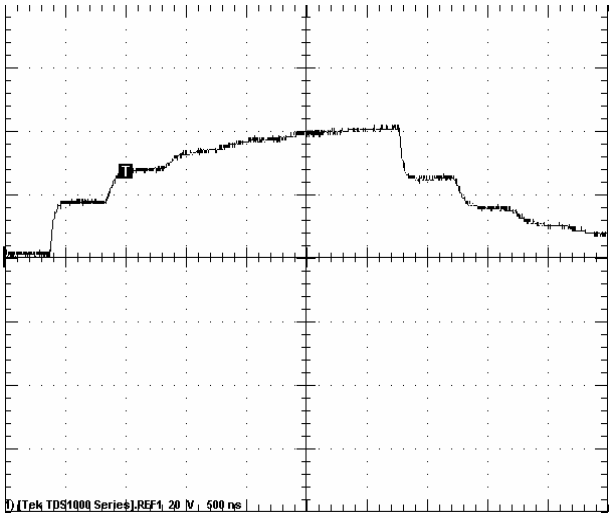

Figure 5- Distorted waveform due to the reflection at the open end.

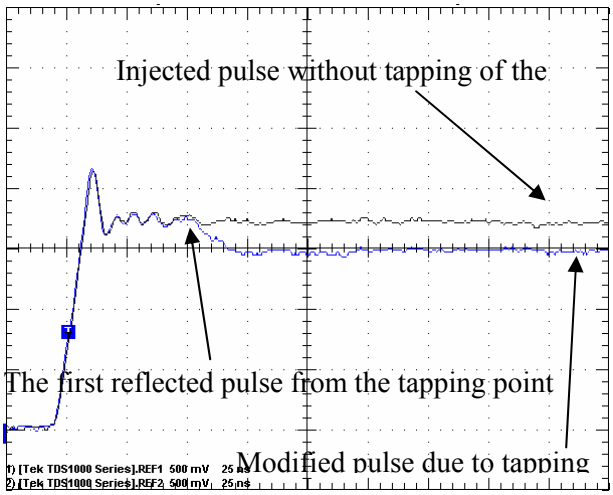

Figure 6 - Modified waveform due the reflection at the tapping point

The initial part of the observed waveform was shown in figure 6 when the cable was tapped 5m away from the sending end.

Once the reflected wave form is captured, the most recently reflected signal has to be identified precisely. Then the calculations can be done. If the first reflection shows lesser traveling time than expected value with respect to length of the service cable, we can assume the cable has been tapped in between.

3.3 Developments

The main objective is to simplify this arrangement to a portable unit. So that checking can be done at the customer premises without any difficulties.

The final arrangement will comprise of following units and circuitries.

- Signal generator
- Display unit
- AD converter
- Processing unit with a micro controller
- Filter

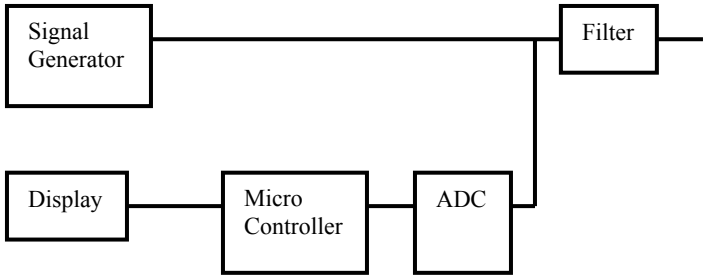

Figure 7- Final Unit with developments

3.3.1 Signal Generator

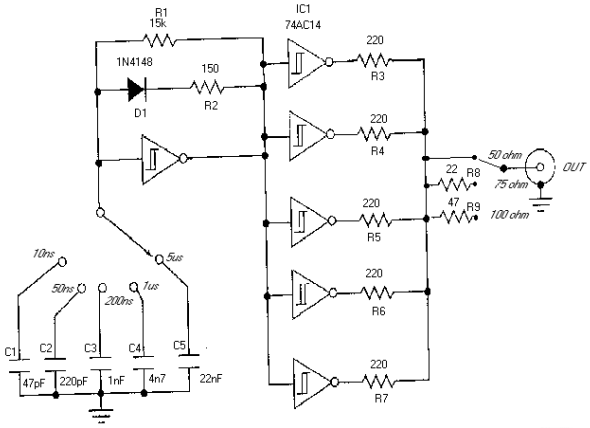

Figure 8 - Circuitry of signal generator

This is the most important part of the entire unit. This generates a square shape wave form with adjustable characteristics such as frequency, duty and amplitude. The shape of the waveform must be so closer to square shape especially without any ripple and the end.

The frequency, duty and amplitude must be adjusted according to the cable conditions such that a clear and observable waveform is displayed.

3.3.2 Display Unit

This is responsible for displaying waveforms. An LCD screen must be used which is capable of displaying waveforms in ns range.

3.3.3 AD converter

The conversion of Analogue signal to a digital format is done by this unit. The higher operating frequency of this will enable to get clear and observable wave format.

3.3.4 Processing unit with a micro controller

Other important functions and formulas are stored in this unit.

3.3.5 Filter

The attenuation of the power frequency in the reflected signals coming down, are done by this unit.

4.0 CONCLUSION

So far our test was carried out with an isolated cable (with out power). Many implementations must be done before it is applied with real world conditions especially with powered cable.

- When the tapping point is so close to the testing unit, mostly to the meter, significant distortion, due to the reflection, can't be obtained. By using a detector with high bandwith and resolution such drawbacks can be avoided.

- According to the connection at the tapping point, the amplitude of the reflected signal may be varied. If the connection is electrically poor, amplitude will be a lesser value and observable distortion will not occur.

- The coupling point of the power cable and detector must avoid high power signal coming in to the signal generator which is harmful to the both generator and oscilloscope.

- A filter, capable of attenuating power frequency must be cascaded with the signal generator and the oscilloscope. By this error free calculations can be carried out

Acknowledgement

It is a great opportunity for undergraduates to enhance their theoritical knowlegde gathered during four years by involving in a project work before career life in the industry.

First of all we would like to thank our Head of the Department , Prof. J.R Lucas for giving us this opportunity. Then we should also mention the great contribution done by Lanka Electricity company and their staff especially giving us this project and providing necessary material. This endeavor made us to get educated in varity of subjects because although the projects is from electrical field it mainly based on communication theories and electronics.

Dr. Karunadasa who helped us throughout the project guiding , encouraging and helping us from the begininng must also be appreciated. Finally our heartiest gratitude goes to the Department of Electronics and the staff for allowing us to use the Digital Labotary for testing.

References

Electronics Design October 1, 1998 magazine