

# GSM Based Solution for Monitoring and Diagnostic of Electrical Equipment

CATALIN PANCU, ADRIAN BARABOI, MARICEL ADAM, ADRIAN PLESCA

Power System Department, Faculty of Electrical Engineering

“Gh. Asachi” Technical University of Iasi

D. Mangeron, no. 51-53, Iasi, 700050

ROMANIA

cpancu@ee.tuiasi.ro, http://www.ee.tuiasi.ro

**Abstract:** - The paper proposes a wireless solution, based on GSM (Global System for Mobile Communication) networks for the monitoring, diagnostic and control of the medium voltage (MV) and high voltage (HV) circuit breakers. This architecture has the advantage that can be used for the monitoring of some electrical and cinematic parameters for the operating mechanism, the alarms being sent via GSM network. Also, the proposed system allows on-line monitoring and diagnostic of the equipment.

**Key-Words:** - GSM communication, monitoring, diagnostic, circuit breaker, microcontroller, data acquisition.

## 1 Introduction

As the social economy is developing fast in 21<sup>st</sup> century, high speed, high performance, and convenience have become a very common demand of people. So as to existing wired communication technology can't yet meet the need of getting communication and information at anytime anywhere. However, the integration of Internet and wireless communication technique make many applications change from ideal into reality, such as remote monitor, diagnostic and control of different electrical equipment and installations. In a word, more and more devices are required to own the ability of wireless communication.

Modern control systems for industrial applications require automated data reading on-line monitoring and batch command processing so remote access is an important feature. One possible solution for remote access is GSM technology, available almost everywhere and requiring no cabling; its costs are sinking now due to struggle for market share between GSM operators, making it very attractive for a large range of applications, Fig. 1. GSM technology can be used for data transfers in two different ways – circuit switching data transfers (CSD), in a comparable way with voice calls, or packet switching (GPRS General Packet Radio Switching) data transfers based on internet technology (TCP/IP), [1].

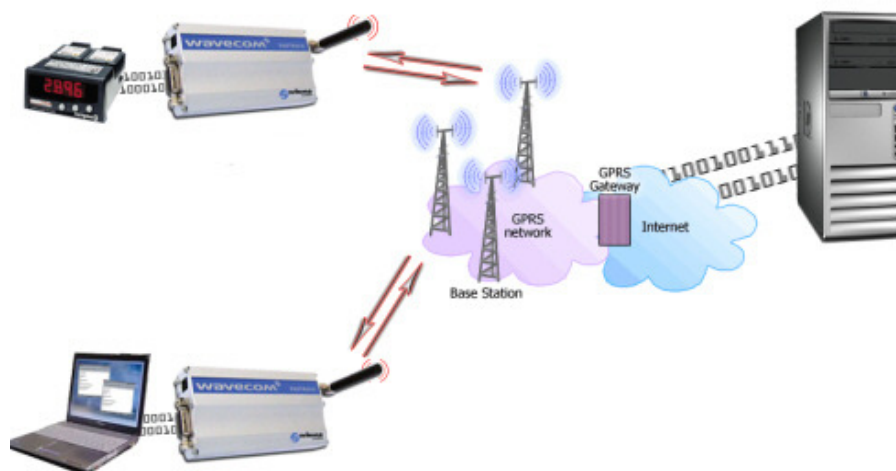


Fig. 1.- System for remote monitoring, diagnostic and control using GSM technology

## 2 GSM as wireless communication technology

GSM is short for Global System for Mobile communication system. It provides three main services of short message, speech communication and data communication. Because service of short message makes the wireless communication module more popular to be used, wireless communication module is also called GSM short message module. GSM short message service has the character of always online, no dialing, low price, large coverage and etc. For GSM technology, short message service is the only one that needn't set up end-to-end channel and also provide service when the mobile device is in point-to-point communication. Short message service is asynchronous communication for sending only one sentence per each message. In GSM system, each message is handled as individual time and transmitted by SMSC (Short Message Service Center).

GSM can offer speed of 9.6 Kbps data communication service when on-line whereas GPRS can offer speed of 100Kbps. Considering the feature of circuit breaker data acquisition and the cost for communication, GSM short message service is suitable to use for transmitting data in large-scale field measurement system. There are two forms of short message service. One is point-to-point, message transmit from one user to another. The other is plot radio, where the message is sent to all registered users by SMSC. Due to point-to-point short message needn't set up specialized communication channel and the cost is cheap, it is adopted.

Each short message can transmit 160 coded data of 7 bits or 140 coded data of 8 bits or 70 UNICODE code. Therefore, GSM short message could be used to transmit data and command in measurement and control systems which have low demands in real-time and transmitting speed, so virgin investment for building wireless communication network could be saved.

GSM module is the Kernel part to realize wireless data transmission. Wireless communication module Fastrack M1306B based on standard of GSM produced by Wavecom company is used in developed application, Fig. 2. Fastrack M1306B module consists of mainframe, antenna, serial communication line, power line. It provides services of wireless modem, wireless fax, short message and speech communication, [2]. The short message service is suitable to apply in the situation of frequent transmittance of small data flow.



Fig. 2.- Mainframe of Wavecom Fastrack M1306B

Remote access solutions are potentially great enhancements for digital industrial control systems because they permit an easier interface to information management systems and reduce the necessity of human presence at system's place. Remote access hardware may not be the same in both parts, for example a GSM modem attached to control system communicates with a normal PSTN modem or even from Internet.

Hardware architecture of an embedded system with GSM remote access capabilities is very simple – a GSM/GPRS modem is attached to one serial port of the existing system's microcontroller and software modules for communication are added to existing firmware. Efforts are mostly in software side, but care should be taken to avoid possible EMC problems caused by GSM module, especially if antenna is very close to sensible analog lines (analog to digital converter's lines, reset or interrupt request lines of microcontroller). Also noise on power supply lines can be a problem due to repetitive current peaks generated by GSM module during transmission.

## 3 Experimental model

The RISC (Reduced Instructions Set Computer) microcontroller is a powerful tool that provides a highly flexible and cost-effective solutions to many embedded monitoring and diagnostic systems, [3], [4].

The central unit has been made around of an Atmel ATmega128 AVR microcontroller, [5] with scheme presented in Fig.3.

Fig. 4 shows the experimental model of the proposed architecture which will be used for monitoring and diagnostic of high and medium voltage circuit breakers.

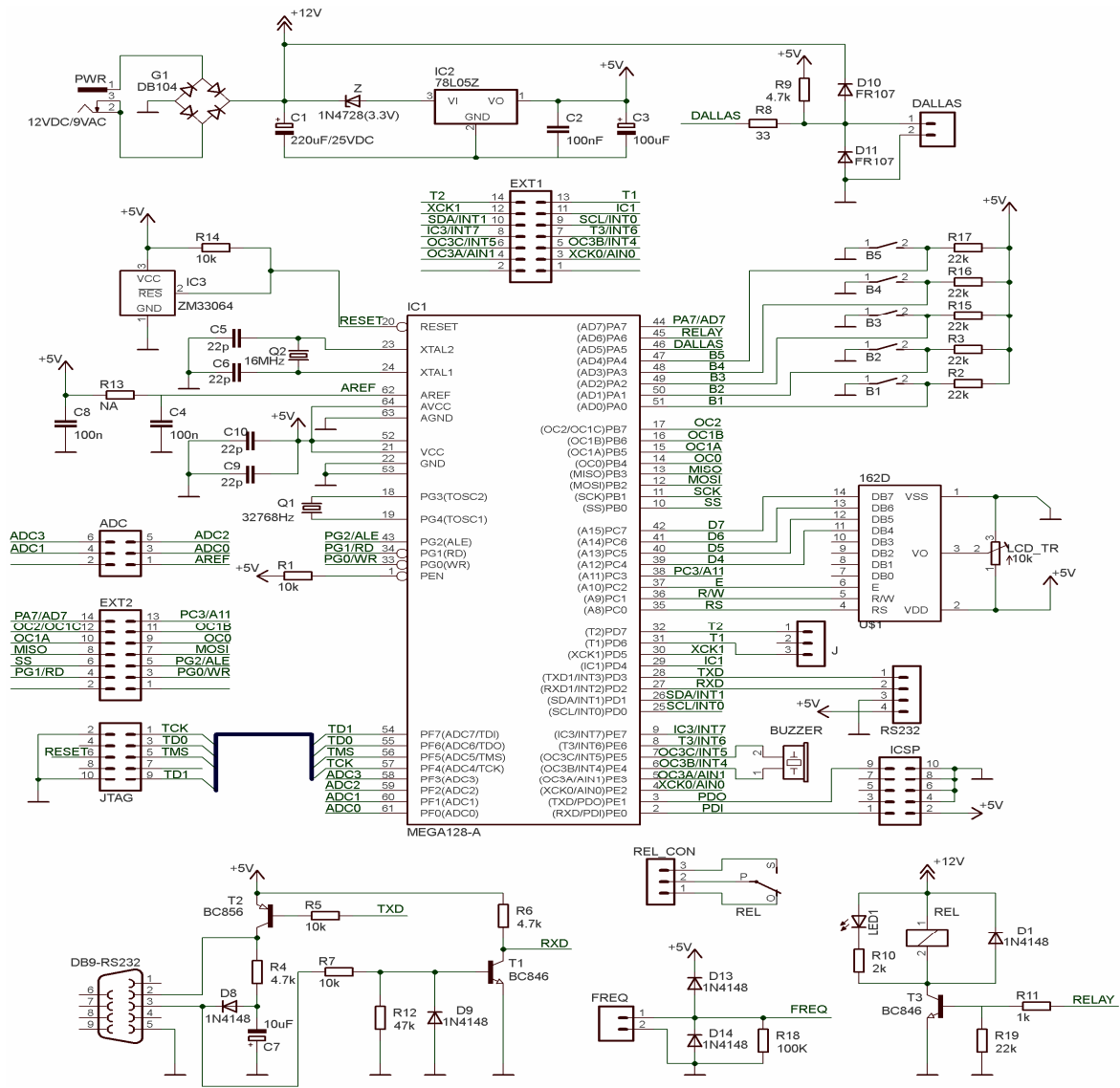


Fig. 3.- Scheme of central unit

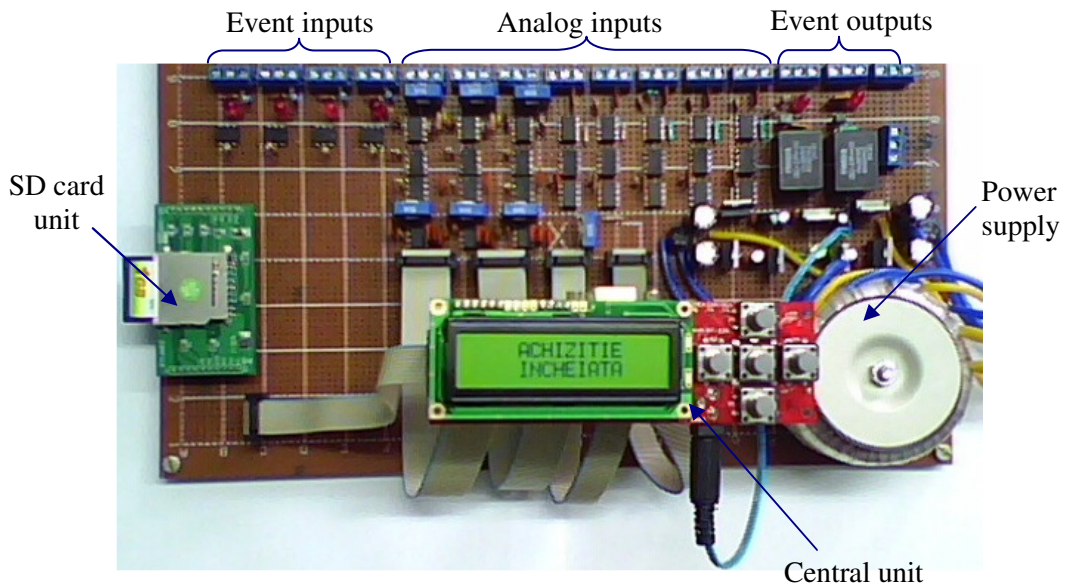


Fig. 4.- Experimental model

### 4 Experimental results

The proposed system has been tested for remote monitoring, diagnostic and control of a MV circuit breaker, [6].

Implementing communication protocols in embedded software is not an easy job, because of limited memory resources and lack of a full-scale operating system.

Embedded programmer should integrate communication tasks and processes into existing system, and these processes require exact timings so they need higher priority than other tasks; this can lead to lower performance for other processes that need also precise timings (data acquisition or processing). Good knowledge of real-time system concepts is essential in developing of communication software.

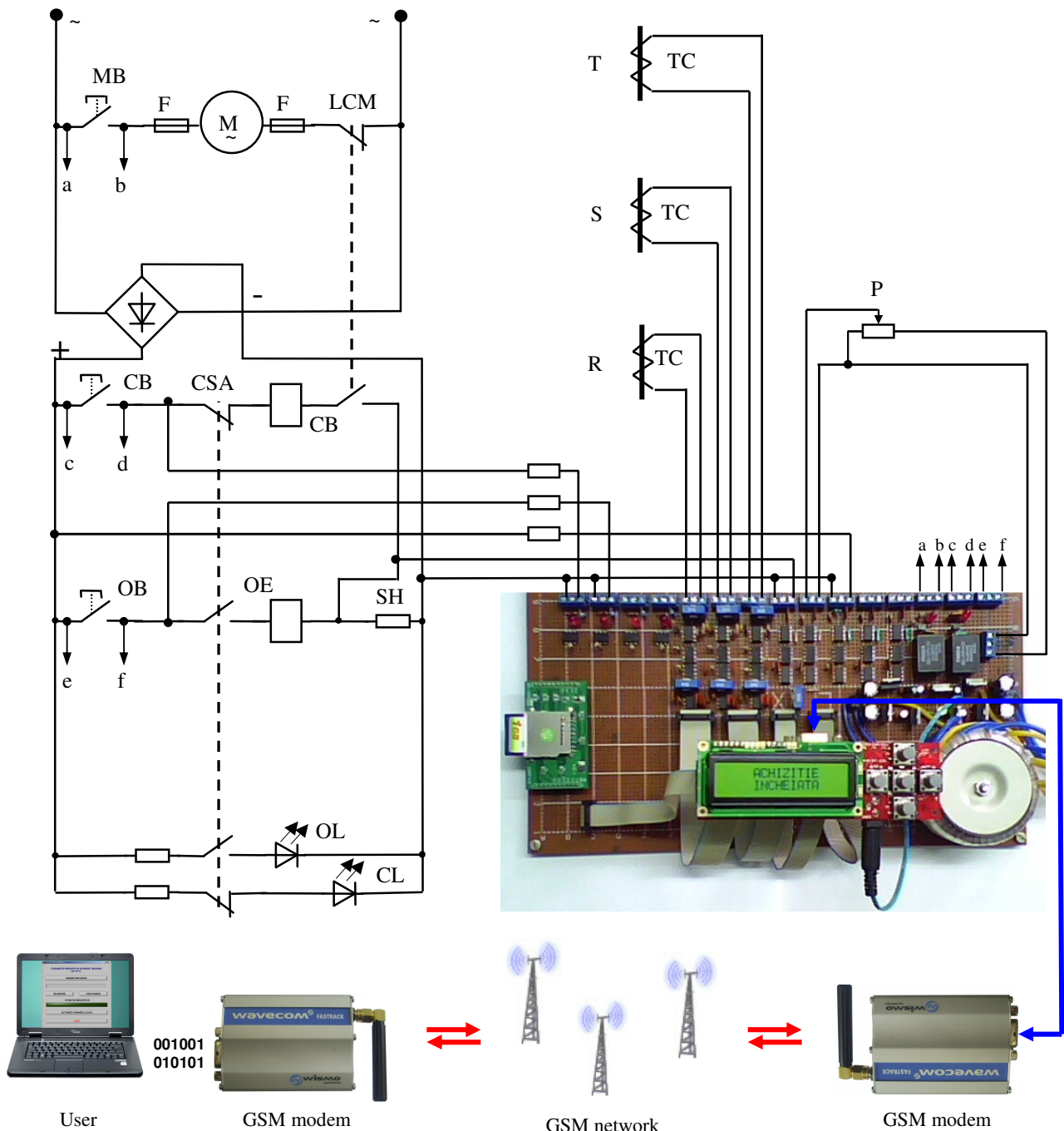


Fig. 5.- Monitoring and diagnostic system of the circuit breaker using GSM technology.

Considering the feature of a remote monitoring, diagnostic and control of the circuit breaker and the cost for communication, GSM short message service is suitable to use for transmitting data in large-scale field measurement system.

One GSM module is used in this system as SMS data sending module. It is in charge of sending information to SMSC in forms of short message. Fastrack M1306B module is connecting at the experimental model by RS-232 serial interface and controlled by AT commands. AT commands was first advanced by Hayes company and became a standard modem command language system.

Before using GSM module to send out short message, it is necessary to set the module first, such as testing the signal strong or not and set short message pattern. There are three interface agreements to control SMS in GSM system, Block Mode, Text Mode and PDU Mode. In this system, Text Mode is used to send farm information and the max length of short message is 140 bytes. Supposed use encode mode of 7 bits, it could send 160 characters.

Another GSM module is used as SMS data receiving module. Its function is to receive short message, and transmit it to computer. Fastrack M1306B module has two modes to receive short message through SMSC. One is received directly by serial interface. Another is received by SIM card. The mode of using serial interface is very easy but it need computer always on line otherwise the information will be lost. So the system chooses the mode of using SIM card to receive short message. Then the information which is received by Fastrack M1306B module would be transmitted to computer by RS-232 serial interface.

The experimental model is capable to acquire the parameters necessary for the monitoring and diagnostic of a circuit breaker, [7], [8]. It has been tested on a MV circuit breaker with rated voltage of 24kV and rated current of 1250A, Fig. 5.

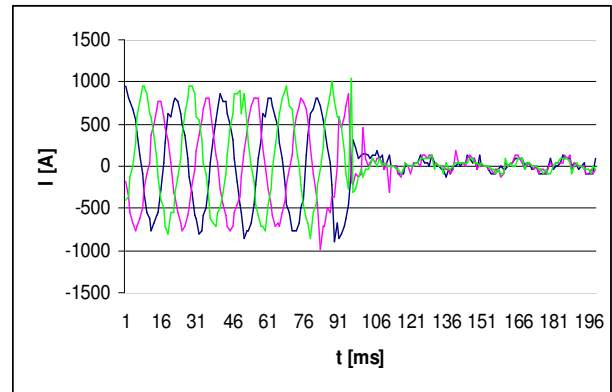
In Fig. 6 are shown some of the parameters recorded by the monitoring and diagnostic system at the trip command.

The experimental model allows to saving the curves on a SD card for ulterior processing. Also, it is capable to transmit alarms and information regarding the status of circuit breaker using a wireless communication (GSM modem in this case).

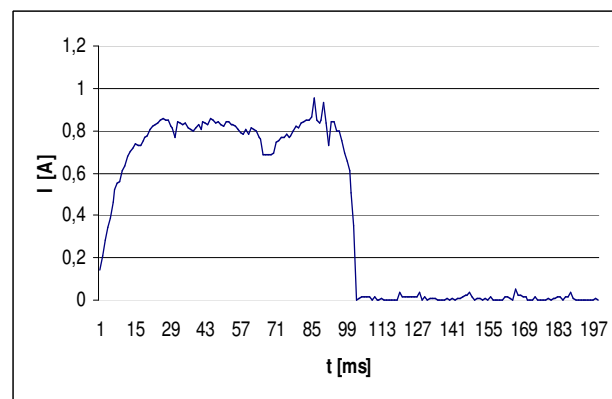
This approach has the advantage that the architecture can be used for the monitoring of the some cinematic parameters for the operating mechanism like as: closing speed, opening speed, closing time, opening time, the stored energy in the operating mechanism and others, [9].

In order to estimates the performances of the intelligent system, the same parameters have been acquired on the same circuit breaker using BCM 200, [10], system made by Hathaway (USA), Fig.7.

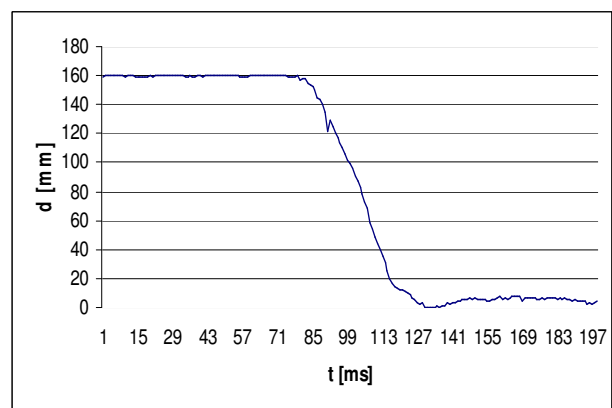
Analyzing the acquired data, it can observe a good similitude between both systems.



a)

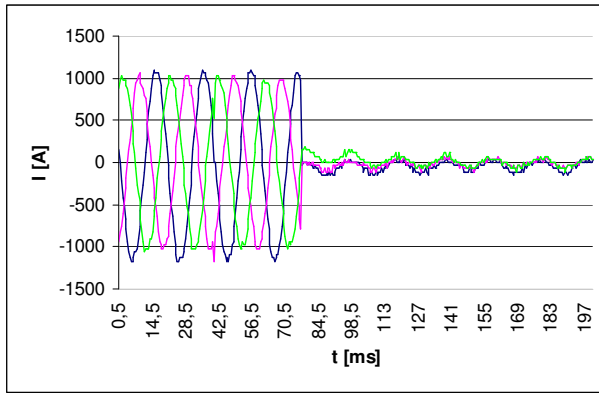


b)

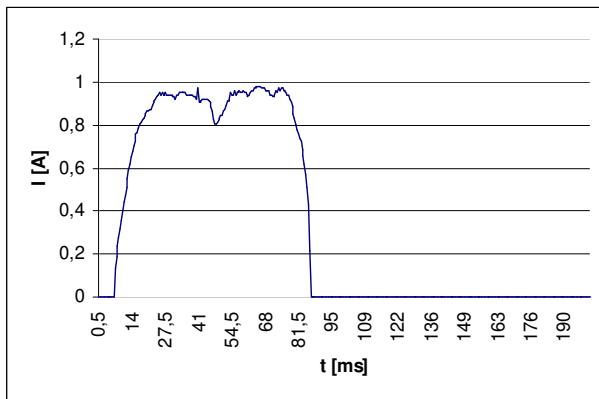


c)

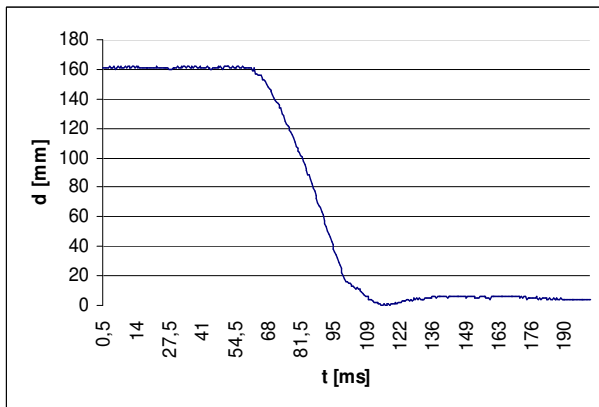
Fig. 6. - Acquired parameters using the experimental model: a) phase currents; b) current through trip coil; c) travel curve at the opening of the circuit breaker



a)



b)



c)

Fig. 6. - Acquired parameters using BCM 200 system: a) phase currents; b) current through trip coil; c) travel curve at the opening of the circuit breaker

## 5 Conclusion

Modern control systems for industrial applications require automated data reading on-line monitoring and batch command processing so remote access is an important feature. One possible solution for

remote access is GSM technology, available almost everywhere and requiring no cabling.

Considering the feature of a remote monitoring, diagnostic and control of the circuit breaker and the cost for communication, GSM network is suitable to use for transmitting data in large-scale field measurement system.

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