

## The wireless notification systems used in car alarm systems

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**Summary.** More than ten thousand cars disappeared in Poland last year. This situation was caused by relatively quick profit on sale of such cars and their components after disassembling. It happens increasingly often that the driver is stopped and the car is taken by force by thieves. The only one method to protect the car consists in its monitoring associated with the use of modern methods of stolen vehicle tracking. The car alarms systems are provided with several functions and protections sometimes efficiently preventing the car theft or making the car harder to steal. The systems become more and more perfect every day but nobody pays any attention to car alarms owing to their common use and particularly frequent false alarms originating from the cars parked in the streets and parking areas. 24 hour security monitoring is the best method to protect a car. There are companies offering *specialized security services in this scope of property, but their services are rather expensive*. The monitoring system using the car positioning on the basis of GPS satellite signal is a good way to protect the car and to find it thereafter. The signal informing about occurred burglary and the present position of the car is transmitted by means of SMS text message via GSM mobile telephony system. Using bidirectional data transmission path in GSM system it is possible to control, to turn ON/OFF any connected device, to download the readings from any sensors in remote mode. GSM system, except of the reading of geographical location of the receiver, makes it also possible to directly read the altitude above sea level, current time and date. It is also possible to read the current velocity of the object after a little processing of data received from satellite. The full monitoring of our vehicle is possible as a result of the combination of GPS and GSM technology. The possibilities offered by the system depend exclusively on the ingenuity and imagination of its designer.

**Key words:** car alarm, GPS, GSM.

### ALARM SYSTEM STRUCTURE AND CONFIGURATION

The following design inputs are required in order to build a system performing the functions of an alarm control panel and transmitting the current alarm status data:

- informing the local area about occurred burglary;
- transferring the data on the occurrence of an event, its place and time;
- hiding the system in a manner enabling further transmission of messages to inform about the current position of vehicles even after disconnection of signalling devices;
- emergency power supply for communication module to enable its further operation even after power supply shutoff,
- inertial tilt sensor protecting against car towing,
- opening sensor for the door, engine hood, trunk lid etc.;
- SMS message about occurred alarm, about the time of its occurrence and geographical position of the car;
- controlling the alarm control panel (enabling / disabling) using the attempt to connect from an authorized phone number (lack of additional pilot) only;
- co-operation with maps e.g. Google.

### CONSTRUCTION OF THE ALARM CONTROL PANEL

The alarm control panel consists of three blocks performing the following functions:

- GPS receiver segment determining the current position of the car;
- GSM modem segment to be used as a communication link;

- micro-controller segment ensuring the system operations management in accordance with elaborated program.

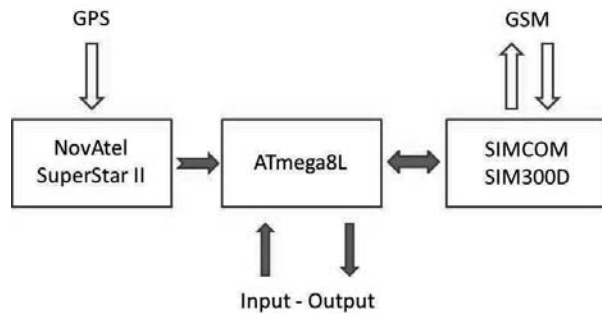


Fig. 1. Block diagram of the alarm control panel

SuperStar II module supplied by NovAtel company has been applied in the system as GPS signal receiver. The module operating in NAVSTAR GPS standard has been designed in the form of 12 channel receiver (receiving the data from maximum 12 satellites simultaneously) and provided with configurable RS-232 interface. StarView software is made available free of charge by the manufacturer in order to enable its configuration, to preview all possible transmission parameters as well as incoming frames in NMEA or binary standard. The receiver position update rate is adjustable between 1Hz and 5 Hz.

After the voltage is applied, available satellites are automatically searched by the receiver and successive frames containing position data are displayed on Tx line of built-in serial interface. The task of the microcontroller is to search the frames and then “to catch” interesting information from \$GPGGA frame about GPS coordinates, time and altitude of the location of an object being monitored above sea level. GSM/GPRS SIM300D modem supplied by SIMCOM has been installed in order to enable the data transmitting and receiving. The modem operating in GSM 900MHz, DCS 1800 MHz and GSM 1900MHz bandwidth has been built as a “cellular phone” without unnecessary elements i.e. keyboard, display, loudspeaker, microphone. AVR Atmega8 microcontroller has been used to ensure GPS receiver and GSM modem operation and RLC passive elements in order to ensure the correct collaboration of the systems. The communication is carried out by means of corresponding AT commands transmitted by a serial interface.

AVR Atmega8 microcontroller has been designed as “a bridge” connecting GPS system with GSM system and enabling the management of GPS receiver and GSM module operation. The commands transmitted by the microcontroller trigger an alarm and send the information about occurred event, its time and location. Its program has been elaborated in Basic language in FastAVR environment and downloaded from the computer by means of STK500 interface and AVR studio 4 program.

The purpose of built – in EEPROM in the system is to save the current status of alarm control panel in case of power supply failure.

## WORKING PRINCIPLE OF THE ALARM CONTROL PANEL

Before the commencement of the system use, determine the number of mobile phone of the person authorized to control the alarm control panel and to receive SMSs with alarm messages. Therefore, in SIM card (by means of mobile phone) cancel all items in the telephone book of the card including those programmed in the factory by operator . ONLY one entry shall be contained in the telephone book of SIM card on the position No 1 in the following form: name of contact: SIM1, number: +48xxxxxxxx, where xxxxxxxx stands for 9 digits of authorized phone number. PIN of the card shall be disabled.

After the card prepared in a manner described above is placed in a basket, the system shall be turned ON by means of a switch installed on the battery. The setting of this switch should be modified until yellow LED3 diode starts to blink. At this time, the main power supply (temporary power pack or target battery of motor vehicle) can be connected.

During the period of about 2 minutes after the system is turned ON, the modem is in course of initialization and registration in mobile telephony operator network. This status is displayed by means of continuously lighting green LED2 diode and LED1 diode blinking with the frequency of about 0.3Hz.

After the correct initialization two short sounds are transmitted by the buzzer to confirm this fact and the normal operation mode of the alarm control panel is commenced. The data on the last operation status are read by the system from EEPROM memory. LED3 diode lights up only if the alarm control panel is enabled or turned off when the alarm control panel is in enabled or alarm status.

The first synchronization of GPS module with satellite by the receiver may take 2 up to even 15 minutes. It depends on whether the alarm control panel was situated in a geographical position other than before prior to turning off and whether the antenna of GPS receiver is “seen” from satellites without any obstacles.

The enabling / disabling and alarm cancelling for the alarm control panel consists in the attempt to communicate with the number represented by installed SIM card. If the attempt to communicate has been made by an authorized person, the incoming connection is rejected by the modem simultaneously changing the status the alarm control panel into opposite one. If the calling number is not conforming with SIM1 item recorded on SIM card of the alarm control panel, the following SMS message is received by the owner of the number saved in SIM1 item:

„Number +48xxxxxxxx attempted to communicate with the alarm control panel!”, where xxxxxxxx stands for the number of person not authorized to control the alarm control panel. The system does not change its operation status. The same happens in case of an ex-directory (private) number calling to the alarm control panel. Then the following information

message is received by an authorized person indicated in SIM1 item on SIM card of the alarm control panel:

“Ex-directory number attempted to communicate with the alarm control panel!”.

In case of an alarm status, the following SMS message is sent to an authorized user:

„Attention, ALARM! GPS data: Time: hh:mm:ss Latitude: xx\*yyyyyy'Y Longitude: aaa\*bbbbbb'b Altitude above sea level: ccc,d m” where:

hh:mm:ss– current time downloaded from GPS satellite: hh hour, mm minute, ss second,

xx\*yyyyyy'Y– Latitude: xx – degrees, yyyyyy minutes, y – E or W,

aaa\*bbbbbb'b- Longitude: aaa – degrees, bbbbbbb minutes, b – N or S,

ccc,d – altitude above sea level: ccc – value in meters, d – tens of meters.

The receiving of the current GPS data frame is carried out with frequency of 1Hz. The data from the part of frame beginning with \$GPGGA marker are processed and transmitted to the user.

In case of the lack of GPS receiver synchronization with satellite, incorrect data are contained in SMS messages.

The data received in SMS can be displayed by means of a computer program with a map e.g. Google Maps. Therefore the user is able to display the visualization of the current position of the receiver and consequently, the position of monitored object.

The frequency of transmitted SMSs with GPS coordinates is adjustable as a result of changes of a constant value in the program; its standard setting is equal to 30 seconds.

The alarm control panel is equipped with two inputs generating alarms after triggering. One of inputs has been designed as NC type and another collaborates with the tilt sensor triggered after the change of the car tilt or the change of its acceleration. NC input can be used to connect the opening sensors for the door, engine hood, trunk lid or to the output of car alarm system installed in the factory.

The tilt sensor consists of a miniaturized metal cylinder and a metal ball placed therein. The ball closes or opens the circuit connected thereto depending on the tilt angle of the sensor. At the time of alarm enabling, the sensor status before the enabling is saved by the alarm control panel. An alarm is triggered as a result of the sensor status change simultaneously provided that the pulse duration is larger than 200 ms. This function is intended to reduce false alarms, for instance caused by the vibration generated by a heavy motor vehicle passing by or by strong gust of wind.

The buzzer has been applied in the model as an actuator. In fact it is possible to apply among others a loud alarm siren or ignition / fuel pump cut-off relay for this purpose.

## CONCLUSIONS

The purpose of the construction of described system was to present the opportunities offered by the coupling of GPS and GSM technology in practice. The alarm control panel described in the present paper has been built as a model system. Therefore the adaptation of the enclosure to intended working environment would be required in case of practical use of the alarm control panel. The use of a mobile phone as a controlling and notifying medium makes it possible to eliminate a frequently occurring problem in case of typical alarm control panel i.e. the loss or destruction of the control pilot. In case of the mobile phone destruction, SIM card can be moved to another phone and in case of theft a duplicate of SIM card is issued for a small fee, but it is more expensive to duplicate the pilot.

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## SYSTEMY POWIADAMIANIA RADIOWEGO STOSOWANE W SYSTEMACH ALARMOWYCH SAMOCHODÓW

Streszczenie. Minionego roku w Polsce zginęło kilkanaście tysięcy aut. Spowodowane jest dość szybkim zyskiem wynikającym ze sprzedaży takich aut oraz ze sprzedaży

zdemontowanych części. Coraz popularniejsze stają się sytuacje uprowadzeń, kiedy to złodzieje zatrzymują kierowcę i siłą odbierają mu pojazd. Jedynym sposobem na ochronę własnego samochodu jest jego monitoring z wykorzystaniem nowoczesnych metod namierzania skradzionego pojazdu. Systemy alarmowe posiadają szereg funkcji i zabezpieczeń, które potrafią niekiedy skutecznie uniemożliwić lub utrudnić kradzież pojazdu. Alarmy samochodowe z każdym dniem stają się coraz

bardziej doskonałe, lecz ich duża popularność a w szczególności częste fałszywe alarmy dobiegające z aut zaparkowanych na ulicach i parkingach powodują, że nikt na nie, nie zwraca uwagi. Najlepszym sposobem zabezpieczenia pozostawionego auta jest całodobowy monitoring. Istnieją firmy specjalizujące się w takim nadzorze naszego dobytku, ale ich usługi te nie należą do najtańszych.

Słowa kluczowe: auto alarm, GPS, GSM.