REMOTE MONITORING OF TEMPERATURES IN AN ELECTRIC CELL

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***Abstract* – In that paper the authors presents an implemented solution for remote temperature monitoring using digital radio signal. The solution is based on radio communication between an acquisition system and a control room at distance. The acquisition system gets three temperatures, creates a data package with security elements and sends them remotely.**

***Keywords*:** *temperature, monitoring, remote, radio, microcontroller.*

1.THE SYSTEM'S STRUCTURE

The designed system for remote monitoring of temperatures is a modular system realized by "Centrul de Inovate si Transfer Tehnologic" - C.I.T.T. Craiova. That system offers the possibility to send via radio waves informations about three temperatures measured in three point of an industrial electrichal connections cell. The structure is presented bellow(figure 1).

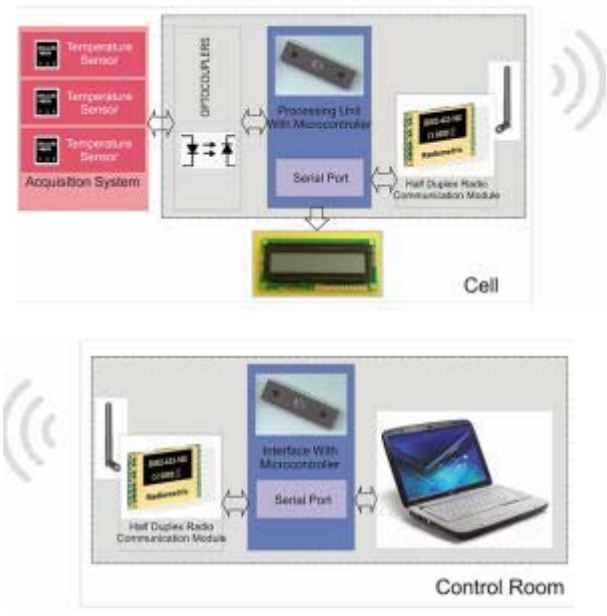

Figure 1. The system's structure

The system named MONICON is composed by two modules: a central unit placed in the control room connected to a computer (MONICON –R) and a one and more units for acquisition and transmition(MONICON-T). The first unit makes the hardware interface between computer and radio transceiver and it can display information and alarms (when temperatures overrides the alert limits) on a LCD.

The central element of this unit is an Atmel 89C52 microcontroller witch communicates in serial 232 standard with radio module and computer. This unit scans three digital temperature sensors separated by very fast optocouplers and creates a digital data packet that is sent via radio module.

2. THE COMMUNICATION PROTOCOL

The remote module stays in wait mode. The computer initiates communication sending a request to a module identified by an address field. This is received by microcontroller which switch the serial sending the package to radio mo dule. The radio module emits to the distance using a digital radio signal on frequency of 433MHz. The second unit receives the request and scans the sensors. All information are used to create a serial package which is sent back to control unit where they are interpreted. All packages have a CRC code to verify the integrity of received data.

3.THE TEMPERATURE SENSOR

The temperature sensor DS18B20 is produced by Dallas Semiconductors is a sensor which do not requires any other components to measure the temperature and it can measure values between -55 °C and +125°C with an error of ± 0.5%.

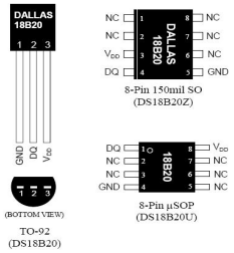

Figure 2. The temperature sensor

The pin description:

GND - ground
DQ - Data In/Out
VDD – power supply
NC – not connected
The resolution of this sensor can be selected between 9 and 12 bits. The conversion oftemperature to digital can be done in 750ms.

4.THE MICROCONTROLLER

The microcontroller 89C52 produced by Atmel is a 8bit processor with the values of clock until 24MHz.

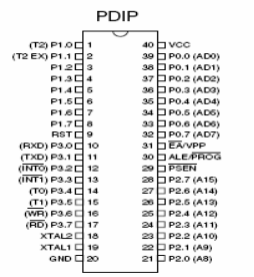

Figure 3.Atmel 89C52 Microcontroller

This microcontroller has the following resources:

- Three 16 bits timers,
- 32 digital inputs/outputs.
- 8 interrupts sources ,
- Serial port.

5.RADIO MODULE

The radio module BiM2-433-160(figure 4) produced by Radiometrix is a half duplex trasceiver on frequency of 433 MHz and has the following features:

- Transmission rate: up to 160kbps,
- Power supply: 3-5V,
- Power of emission: 10mW.

Figure 4.Radio module BiM2-433-160

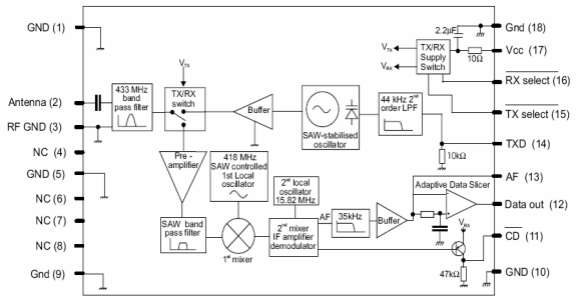

Figure 5. The structure of BiM2-433-160

Pin description:

RF GND *pin 1 & 3*
RF ground pin, internally connected to the module screen and pin 5, 9, 10, 18 (0 Volt). This pin should be connected to the RF return path (e.g. coax braid, main PCB ground plane etc.)
Antenna *pin 2*
50O RF input from the antenna, it is DC isolated internally. (*see* antenna for suggested antenna/feeds).
0Volt *pins 5, 9, 10, 18* Supply ground connection and screen.
CD *pin 11*
Carrier Detect - When the receiver is enabled, a low indicates a signal above the detection threshold is being received. The output is high impedance (50kO) and should only be used to drive a CMOS logic input.
RXD *pin 12*
This digital output from the internal data slicer is a squared version of the signal on pin 13 (AF). It may be used to drive external decoders. The data is true data, i.e. as fed to the transmitter. Load impedance should be >1kΩ and <1nF
AF *pin 13*
This is a buffered and filtered analogue output from the FM demodulator. It has a standing DC bias of 1.2 volts and 400mV P-P base band signal. It is useful as a test point or to drive linear decoders. Load impedance should be >2kΩ and <100pF.
TXD *pin 14*
This DC coupled modulation input will accept either serial digital data (0V to Vcc levels) or High level linear signals. Input impedance is 10kΩ.
TX select *pin 15*
Active low transmit select. 10kΩ internal pull up to Vcc.
RX select *pin 16*
Active low receive select. 10kΩ internal pull up to Vcc.

Pin 15 TX	Pin 16 RX	Function
1	1	power down (<1µA)
1	0	receiver enabled
0	1	transmitter enabled
0	0	self test loop back

Vcc *pin 17*
+ve supply pin. +3.0 to +5.5 volts @ <20mA . The supply must be clean < 20mVP-P ripple. A 2.2µF decoupling capacitor and 10Ω series resistor are used internally to filter the supply.

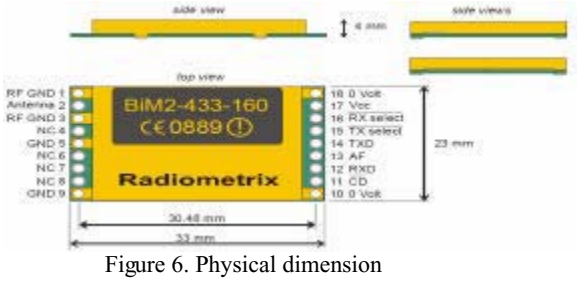

Figure 6. Physical dimension

6. THE ANTENNA

Three types of integral antenna are recommended and approved for use with the module:

A) ***Helical*** Wire coil, connected directly to pin 2, open circuit at other end. This antenna is very efficient given it's small size (20mm x 4mm dia.). The helical is a high Q antenna, trim the wire length or expand the coil for optimum results. The helical de-tunes badly with proximity to other conductive objects (figure 7A).

B) ***Loop*** A loop of PCB track tuned by a fixed or variable capacitor to ground at the 'hot' end and fed from pin 2 at a point 20% from the ground end. Loops have high immunity to proximity de-tuning(figure 7B).

C) ***Whip*** This is a wire, rod ,PCB track or combination connected directly to pin 2 of the module. Optimum total length is 16cm (1/4 wave @ 433MHz). Keep the open circuit (hot) end well away from metal components to prevent serious de-tuning. Whips are ground plane sensitive and will benefit from internal 1/4 wave earthed radial(s) if the product is small and plastic cased(figure 7c)..

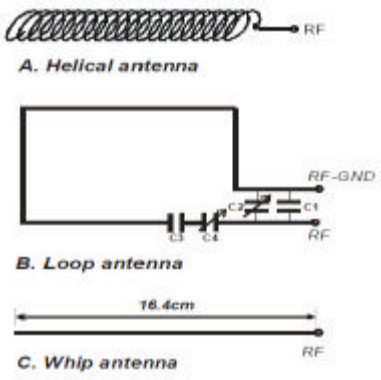

Figure 7. The antenna

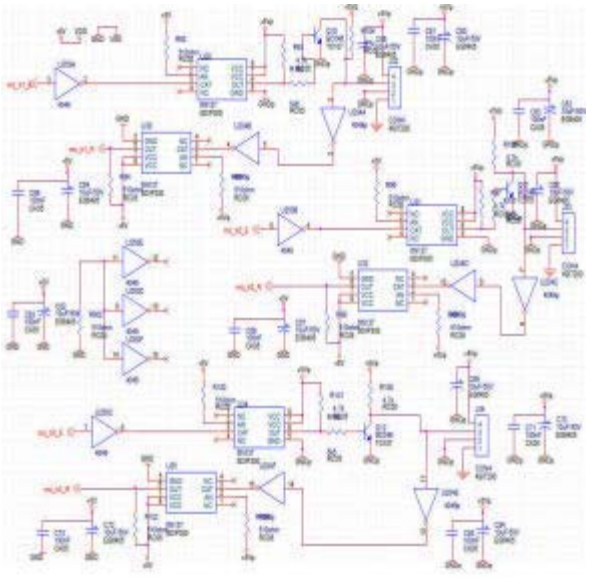

Figure 8.The acquisition block

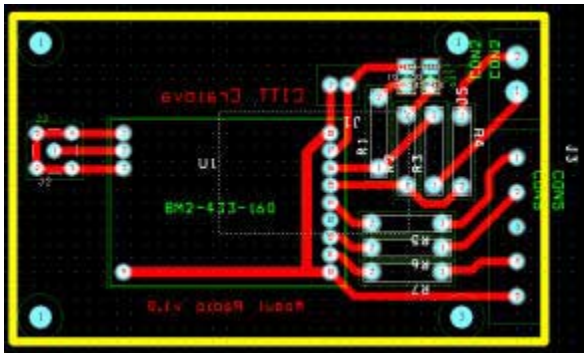

Figure 9.Radio unit

In figure 8 is presented the schematic of acquisition board.

7.SOFTWARE INTERFACE

For computer was developed in Visual Basic a win32 application(figure 10). That permits to make changes in the settings of the system(critical levels of temperatures, alarms) and display information about the monitored temperatures.

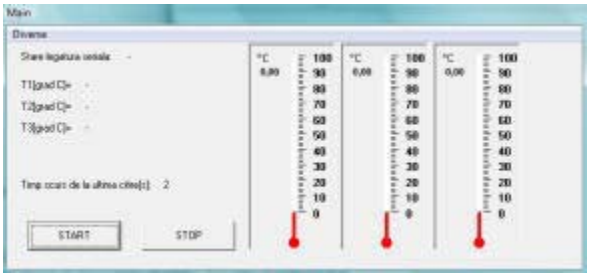

Figure 10. Software interface for PC

8. CONCLUSIONS

The system has been implemented and successfully tested to ICPE Bucuresti. The acquisition system was mounted in a cell where the electric conductors have the nominal current around of 1250A.

Figure 11. The acquisition board

The emission part was introduced in measurement devices compartment(figure 13). For the connection between sensors and acquisition board was used a network cable with eight wires disposed into electric field created by power conductors(figure 12). This solution was adopted to test the influences of electric field against the system.

Figure 12. The emplacement of sensors

Figure 13. The emplacement of acquisition board

Figure 14.

References

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[5] *** - Dallas 18B20 Temperature sensor. Datasheet