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# Using Mobile Phones with android OS for Measuring Hazardous Gas Concentrations Detected using Electronic Nose (E-Nose)

**Prayas Tiwari[1], Ashish Pokhriyal[2], Pankaj Rawat[3], Charu K. Gupta[4], Sunita Narang[5], and Arijit Chowdhuri[6]**

[1,2,3,4,5,6]*Acharya Narendra Dev College (University of Delhi), Kalkaji, New Delhi*

**Abstract: Existing gas sensors with small size and rigid construction allow both online and offline measurements at domestic or environmental sites, however single sensors designed to detect specific gases fail to muster the final hurdle because of "cross-sensitivity" problem. In the last two decades detection of simple and complex gas mixtures by means of an array of electronic sensors has led to the development of so called 'Electronic Nose' (E-Nose). E-Nose comprises of an array of partially selective sensors where each 'sensing element' behaves like a receptor by responding to different odours (gases) to varying degrees. In the present work gas sensing measurement characteristics data, from four partially selective gas sensors constituting the E-Nose, are acquired onto an interfaced digital multimeter (DMM) with RS - 232 port (DB-9 female). A bluetooth dongle with DB-9 male connector is mated onto the RS – 232 port of the DMM and thereafter readied for wireless broadcast of the acquired data from the E-Nose. The bluetooth dongle when interfaced with the DMM is configured with the Data Terminal Ready (DTR) pin switched ON with a 3.3V dc supply. Successful data transfer is achieved through synchronization of the bluetooth dongle and the DMM using TeraTerminal emulator. Synchronization process includes setting of the baud rate, data bits, parity and rebooting of the bluetooth dongle necessarily in that order.**

## 8. INTRODUCTION

Mid-seventies saw the emergence of the concept of an Electronic Nose (E-Nose) wherein it replaced preferential method of analytical chemistry for identification of components of a mixture. This change could be attributed to the development of highly sensitive and specific gas/odour sensors and advanced methods of data analysis. Development in personal computing along with creation of advanced pattern recognition techniques gave a fillip to the unique method of identifying complex constituents. Worldwide researchers recognized the fact that constituents of a mixture of substances can only be identified if and only if a pre-calibration phase had been undertaken beforehand. It was envisaged that the 'pattern'could then be matched with 'signatures' of individual components.

E-Nose are classified as broadly responsive sensor system generating complex multi-dimensional measurement data and that use pattern recognition techniques to match measured 'patterns' to previously 'seen' patterns.

Gas sensing data from E-Nose is generally collected onto computers through complex wired networks. However safety aspects and /or human limitations demand remote monitoring. Many protocols including Bluetooth, Zigbee networks, Ethernet etc. [1 - 6] are in use worldwide to collect gas sensing data for analysis.

Generally, data on the DMM is collected and analyzed locally on a laptop using a USB interface. However, real-time measurements in field demand that hazardous gas sensing data be collected safely and hence the need for remote monitoring. The present study seeks to develop a hardware solution whereby gas sensing data acquired on a digital multimeter is seen on an Android OS enabled device using bluetooth wireless protocol.

## 9. EXPERIMENTAL

In the current investigation gas sensing data from an Electronic nose (E-Nose) is acquired onto a Digital Multimeter (DMM) for measurement. The E-Nose consisting of an array of four partially selective gas sensors, sources gas sensing data to the DMM (Protek - 506) by means of a 'smart' switch. The 'smart' switch allows autonomous collection of gas sensing data by sequentially accessing each gas sensor at a user defined time interval (1 – 15 seconds).

The aim is to transfer data acquired onto the DMM to a user having Android OS enabled device wirelessly. In view of this a bluetooth dongle is interfaced with the RS – 232 port of the DMM and necessary hardware changes made in the dongle. The DB - 9 male connector on the bluetooth dongle is mated to the RS – 232 port of the DMM.

In order to interface the Protek 506 DMM to Android OS device (in this case a Samsung smartphone) using bluetooth dongle initially the dongle is configured. The Android OS device ought to have Grid-in-Hand® Mobile Grid application preinstalled (available for free on Google Play). The dongle is

thereafter connected to the RS - 232 port of the DMM and both are switched ON. After switching ON the bluetooth mode on the Android OS device, connection is established between the dongle and DMM. Setting of the trigger option in the Grid-in-Hand® Mobile Grid application is thereafter achieved. Pressing of the trigger on the Android OS device allows it to receive data from the DMM interfaced with the dongle. Any internet connection on the android device allows it to post the data acquired through grid on the internet.


**Figure 1: Protek – 506 Digital multimeter with RS – 232 port (female DB - 9)**

## 10. RESULTS AND DISCUSSION

Data acquisition broadly refers to the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. In the present investigation, the DMM measures real-time hazardous gas sensing data and transfers the corresponding digital-numeric values to bluetooth data transfer tool dongle.

Protek 506 and bluetooth dongle both use DB - 9 or RS - 232 port to transfer digital data. The pin out diagram for a typical male DB - 9 connector is given below:

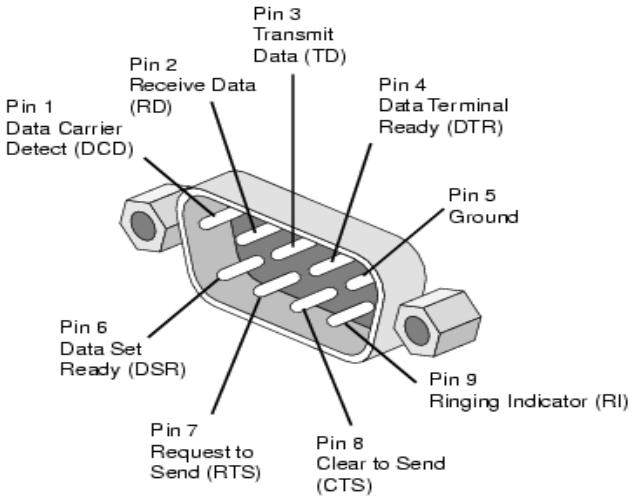


**Figure 2: Pin-out of the DB – 9 male connector**

The DMM 'Protek 506' is initially configured with a baudrate of 1200 bps and set to even parity. With seven data bits and two STOP bits.

For seamless gas sensing data transfer the bluetooth dongle is thereafter set-up to match the Protek – 506 configuration using the freely available 'TeraTerminal'emulator. Sequential chain of commands that are executed is mentioned as hereunder:

- SU, 1200 (To set the Baud rate as 1200 bps)
- S7, 1 (To set the data bits as 7)
- SE, E (To set parity even)
- R, 1 (To save the configuration and reboot the bluetooth dongle)

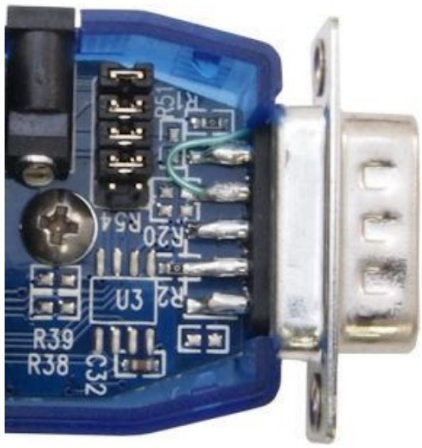


**Figure 3: Bluetooth dongle with jumper settings for wireless data transfer**

In order to transfer data seamlessly from Protek - 506 DMM using RS - 232 port, its DTR (Data Terminal Ready) pin was switched ON by sourcing a 3.3Vdc supply. The details are shown in Figure 4. Both bluetooth dongle and Protek - 506 DMM are then synchronized for successful data transfer.

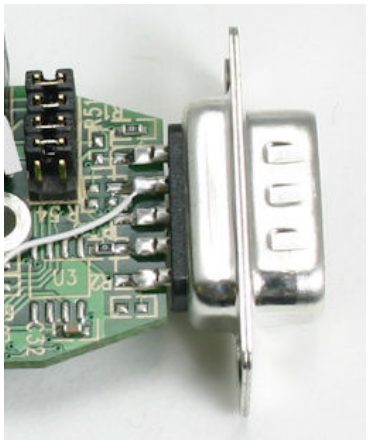

**Figure 4: Bluetooth dongle with 3.3Vdc supply for running in DTR mode**

Now in order to transfer data from bluetooth dongle to Android OS device, need to install an application was seen. Grid-in-Hand® Mobile Grid application available for free on Google Play was identified to suit the needs of the current data transfer. It was installed on Samsung smartphone (Android OS) and post-installation the bluetooth dongle was synchronized for data transfer. Synchronization was achieved by sending a configuration command 'OD' following the given sequence

Open application > Options > Trigger Options > Set Trigger Command 1 and check on As HEX and Set OD as the configuration message.

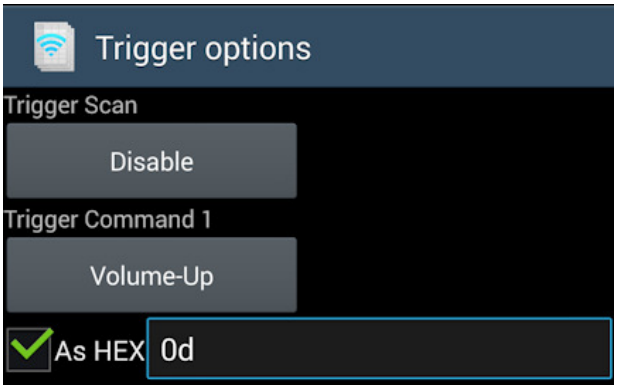


**Figure 5: Setting of trigger for data acquisition through bluetooth protocol**

When the data is transferred successfully from Protek – 506 DMM to the Android OS device through the bluetooth dongle, then Tx/Rx alternately blink on the LCD screen of the DMM. Here, Rx indicates Receiving/Incoming and Tx means Transferring/Outgoing. The data is further uploaded onto internet using Grid-in-Hand® Mobile Grid application.

## 11. CONCLUSION

Wireless transfer of hazardous gas sensing data from partially selective gas sensors constituting the E - Nose has been shown to be successful using bluetooth protocol. 'Smart' switch enabled gas sensing data has been measured on an Android OS smartphone. Acquisition of the data and posting of the same on the web has been successfully carried out using free to download Grid-in-Hand® Mobile Grid application. The whole system has been shown to transmit data wirelessly in a robust manner upto a range of 10 metres under trying field conditions. Autonomous operation of the E-Nose has been vindicated with wireless gas sensing data acquisition on an Android OS device as well as web.

## 12. ACKNOWLEDGEMENT

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