A COMMERCIALLY VIABLE, RELIABLE, LOW COST, MICROCONTROLLER BASED ALTERNATE CNG PRESSURE LEVEL INDICATOR FOR EFI AUTOMOTIVE VEHICLES

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ABSTRACT: *In CNG kits for efi automotive vehicles, the most prone to failure component is the CNG level indicator that is controlled through the ECU/Advancer chip present in the automobiles. A novel, low cost, reliable, microcontroller based CNG pressure display is being proposed in this paper that could be an alternate to the existing CNG level indictor, independent of any ECU/Advancer interface.*

Key Words: **: ECU: Electronic Control Unit, CNG: Compressed Natural Gas, EFI: Electronic Fuel Ignition**

1. INTRODUCTION

Automotive cng kits for efi engines have a cng level indicator cum switch to display the cng pressure along with the manual changeover option between petrol and cng. Usually the cng pressure level indicators are controlled by the advancer/ecu chip in the efi automobiles. These indicators work on the sensing mechanism from the analog pressure gauge, based upon variable resistance transducers. The average life of the display system varies from 2 to 3 years depending upon the make and model of the cng kit. Usually the pressure level indicators are the first to get damaged in cng kits and the replacement of the indicator is costly.

A microcontroller based low cost alternate display mechanism for the cng pressure indicator has been proposed that could be easily installed and calibrated with the existing pressure indicators, has got better reliability, works independent of the ecu or the advancer interface and has an accuracy equal to that of the original level displays that come with the costly cng kits. An alternate "snapshot" approach has been suggested in this project that is much simpler than usual calibration methods. Moreover this display could be interfaced with any cng kit, without any restriction, that utilizes a variable resistance pressure sensing transducer.

2. DETAILS

Automotive CNG kits for efi engines have a CNG level indicator cum switch to display the CNG pressure along with the manual changeover option between petrol and CNG. Usually the cng pressure level indicators are controlled by the Advancer/ECU chip in the efi automobiles. These indicators work on the sensing mechanism from the analog pressure gauge, based upon variable resistance transducers. The average life of the display system varies from 2 to 3 years depending upon the make and model of the CNG kit. Usually the pressure level indicators are the first to get damaged in CNG kits and the replacement of the indicator is costly.

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3. DISCUSSION

The major problem with the displays that come with the CNG kits is their poor reliability and dependency on the ECU/Advancer interface for proper operation. The average life of such displays varies from 2 to 3 years and once damaged, involve a substantial amount of money for their replacement. A commercially viable solution has been sought by removing its reliance on the ECU. The system is based upon, low cost yet powerful 8 pin PIC 12F675 microcontroller. The sensing mechanism is based upon the *Snapshot* approach. The variable voltage input from the variable resistance based gauge transducer, whose resistance variation range is from 2.2 Ω to 90Ω for a pressure varying from 0 psi to 200 psi. The system utilizes the inbuilt A/D converter of the microcontroller that converts this analog signal into its digital equivalent. The software first calibrates the variation of the pressure sensing gauge. The level control range is divided into three segments. Full pressure within the range from 180 psi to 220 psi, medium level from 100 to 180 psi, low level from 50 to 100 psi and then the reserve CNG pressure range that lies from 0 to 50 psi.

The system is extremely simple ***(ref. figure 1)*** in construction and involves only the controller, a 7805 regulator one 300 Ω resistor, three level indicating diodes and a manual switch for calibration range entry ***(ref. pictures 1and 2)***. The versatility of the system is high as the device is CNG kit independent and could be used with any CNG kit that uses a variable resistance based pressure sensing transducer (or even a three wire voltage based pressure sensing transducer.

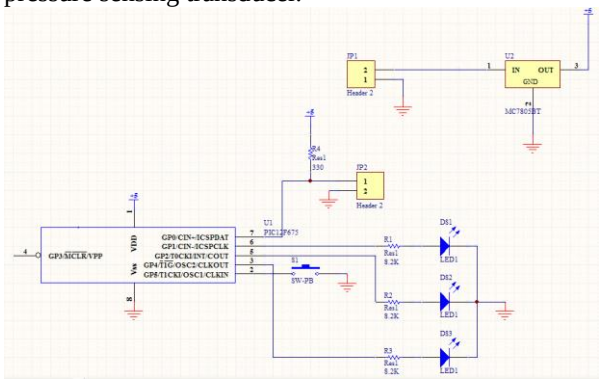

Fig. 1

3.1 "SNAPSHOT"APPROACH TO CALIBRATION

A new approach for calibration has been suggested that is much simpler as compared to other calibration approaches. Instead of adjusting the variable resistance to set the voltage in a certain range, the system is designed with a fixed resistance of 300 Ω and the variable resistance of the pressure sensing transducer forming a voltage divider ***(JP2 connectors, ref figure 1)***. The system is entered in the calibration mode by pressing the switch for about five seconds. It then waits for the user. The user can then set the desired pressure point on the transducer (by adjusting the CNG pressure by virtue of the CNG tap on the cylinder) and then press the button again to store a "snapshot" of the particular voltage at that point in the EEPROM of the micro-controller. Snapshots for Reserve, Minimum, Half ,Full and Over points can be stored.

The pressure thresholds for the above mentioned range segments, in terms of the voltage levels calibrated with a 5V system value, are stored in the in built EEPROM of the controller.

The sensed pressure value (in terms of voltage scaled to 5 V full scale value) from the transducer is first converted from analog to the digital format by an 8 bit accuracy Analog to digital converter of the controller. The vales are compared by the stored threshold reference voltage values in the EEPROM. Based upon this comparison the controller decides to illuminate the display indicator.

3.2 SOFTWARE

The software for this system has been written in C and assembly using the CC5x compiler. Since the internal memory of the microcontroller is limited to 1K, the program has been written in such a manner as to minimize the source code length. Procedure for calibration (PROC A , Figure 2) has been carried out in a for loop that executes five times to input and store the five values for RESERVE, LOW, MID , FULL and OVER pressure voltage snapshots. There is no hardware oriented control in the system except the pressure benchmark setting procedure that is accomplished using a single mechanical switch. Lack of external hardware adjustment makes the system versatile and can be re-calibrated quickly. The program flow ***(ref. figure 2)*** clearly shows the involvement of various loops and subroutines to reduce the overall program space.

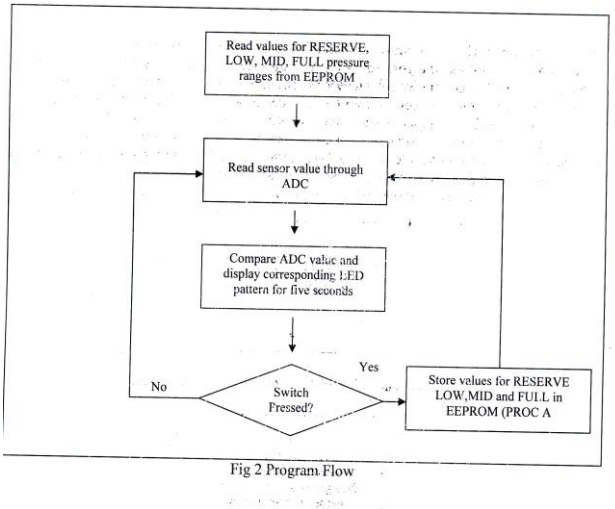

Fig 2

FIG. 3

3.3 PERFORMANCE EVALUATION

No design could be perfect till evaluated and tested in depth. The prototype card is tested for a continuous operation on various vehicles i.e Suzuki Cultus, Hyundai Santro, Honda City and Nissan Sunny with various CNG kits viz Landiranzo, Lovato and BRC. The system's performance was stable, in line with the designated calibration values and no substantial variation was noticed with regards to temperature variation, which is one of the major causes of shifts in performance of electronic devices and reduction in accuracy.

4. CONCLUSION

A low cost, reliable, easy to install and use, commercially viable solution to the CNG kits gas pressure display problems has been proposed. The proposed system is CNG kit independent, has been trialed, tested and has been found to work well without the involvement of the ECU/Advancer of efi cars. The solution is suitable for a direct replacement or can work alternatively in parallel to the installed system without any need to disembark the original system.

For future enhancement, inclusion of the overheat indication of the engine alongwith the cooling fan status of car engine and the coolant flow status could also be embedded into the system. These factors hamper the car and the CNG kit performance badly.

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