

# Design and Implementation of Automotive Instrumentation Display Using FPGA

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**ABSTRACT:** The scope of the paper represents the design of an automated instrumentation display using FPGA, (Field Programmable Gate Array) wide application of this display is in cars, buses, trains, etc. The designed automotive instrumentation display gives the information such as speed of the vehicle in km/hr, status of the seat belt and hand brake and temperature of the engine in °C. All modern technology is in need of Embedded FPGA which is more powerful tool for development. FPGA's are specially designed with system-on chip with strong reprogrammable circuitry constituted huge number of logic blocks(Configurable Logic Blocks).FPGA architecture and mapped onto the Configurable Logic Blocks (CLB) of the FPGA. FPGA provides facility to interact with low or high interfaces and power consumption is very less. FPGA devices are cheaper compared to traditional FPGA's.

This paper mainly focuses on the design and implementation aspect of automotive instrumentation display with various modules for processing the sub modules and display the output in the processed form to help the driver to take proper decision at regular interval to ensure the safety measures while driving. Xilinx Spartan 3 FPGA board is used as hardware and VHDL is used as software language for developing the automotive instrumentation display.

**KEYWORDS:** FPGA, Spartan3 Board, seven segment display, LCD display, VHDL.

## I. INTRODUCTION

In rapid going industry, new technology adoption is very much required based on the customer needs. So, Display module plays vital role in the entire display system to provide need basis information to the external world.



Figure 1: Traditional electromechanical instrumentation

Unlike traditional electromechanical instrumentation shown in the figure 1, automotive instrument display is shown in the figure 2 allows for the dynamic organization of information. The driver can choose to have the system display only

# International Journal of Innovative Research in Science, Engineering and Technology

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those gauges such as a speed, status of the seat belt, hand brake and temperature wanted at the moment in real time switching to others on the fly as needed.

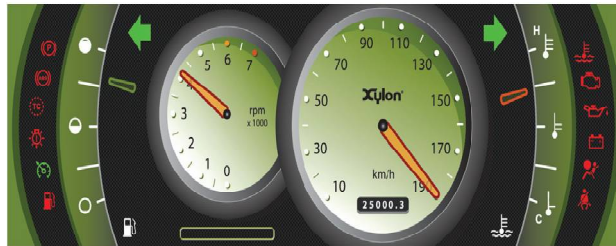


Figure 2: Automotive instrumentation display

The automotive instrumentation display of the design and implementation of FPGA acts as a standard display interface, detailed information of this paper is focused on the system architecture, hardware design and software programming. This display ensures the portability with any user and can display any information. The Proposed algorithm produced excellent simulation results with low power utilization and less execution time with better performances. Vehicle parameters such as speed, seat belt, brake system and engine's temperature is shown in seven segment display and LCD display.

FPGA (Field Programmable Gates Array) provides an impacted size and low power consumption solution. FPGA provides high clock frequency, high operations per second and ensures the portability, reusability, scalability, low cost, parallel processing, and capability of interacting with high or low interfaces, security.

Seat belt act as safety enhancement belt of a vehicle to secure the passenger from hazardous accidents. Seat belt usage in the vehicle avoids the injuries during crash and prevents the occupant from throwing out of the vehicle. Positioning of the occupant is based on the seat belt adjustment and reduces the collision between the occupant and interior parts of the vehicle.

Advanced technology updates the car with strong brake system, which is fixed at every wheel. Front brake performs active role compared to rear brake for stopping the vehicle. Older vehicles have drum type brakes and modern cars have disc type brakes. In modern vehicles, Disc brakes are fixed at the front wheel for efficient application of brakes and rear wheel have drum brakes to support the vehicle for applying the brake.

Temperature gauges measures the engine coolant temperature to indicate the status of the coolant which is present on the dashboard of the vehicle. Over heating or cooling of the engine causes damage to the vehicle. If engine coolant temperature is high indicates failure of water pump gasket or failure of coolant. If engine coolant temperature is low indicates the breakage of temperature gauge.

Paper is organized as follows: Section II describes about Literature survey. Section III Implementation aspects of display using FPGA. Section IV describes the methods used for designing the display. The sequence diagram represents the sequence of data flow in the process that is given in Section V. Section VI represents simulation results after process. Finally, Section VII gives the conclusion.

## II. LITERATURE SURVEY

Paper 1: "Real Time Design & Implementation of Digital Speedometer on FPGA."

This paper gives the insight of the design and implementation of the speedometer using FPGA. Measured speed of the vehicle is displayed using speedometer. Pulses are sensed by the sensor of the digital speedometer and compute the speed and output is diverted to seven segment display for display. Hall sensor detects the speed and passes this output to FPGA for processing and finally speed value displayed in the display. Advantage of this paper is speed estimation is easy but other vehicle parameters cannot be computed.

Paper 2: "Speed controlling using distance detector in moving vehicle."

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This paper describes how the distance detector controls the speed of the vehicle. Radar consists of transmitter and receiver. Transmitter transmits the signal in all the directions. This transmitted signal hits the target and reflects back the scattered signal with different frequency. The receiver receives the signal and filtering of the noise takes place by applying signal processing technique. Speed is monitored continuously using Doppler radar by measuring the distance between the target and the vehicle using Microcontroller. Disadvantage of this project is implementation cost is very high due to microcontroller and Doppler radar.

Paper 3: “Automotive engine temperature control employing apt temperature measurement and control measure.”

This paper gives the detailed description about the automotive temperature measurement system and its operation. Serial communication is used for transferring the data to the PC through keyboard input. Temperature sensor measures the coolant temperature and displayed on the display to take the decision to control the temperature. Disadvantage of this project is communication speed is lower due to RS 232 communication.

Paper 4: “Seat belt safety features using sensors to protect occupant.”

This paper gives the inbuilt technique of seat belt mechanism by ensuring the safety of the occupant. The touch sensors of the vehicle send the signal to the micro controller regarding the occupancy and door lock status to take decision about wheel lock activation. Advantage is seat belt ensures the protection to the occupant.

### III. DESIGN AND IMPLEMENTATION

The functional block diagram of the automotive instrumentation display is shown in the figure 3.

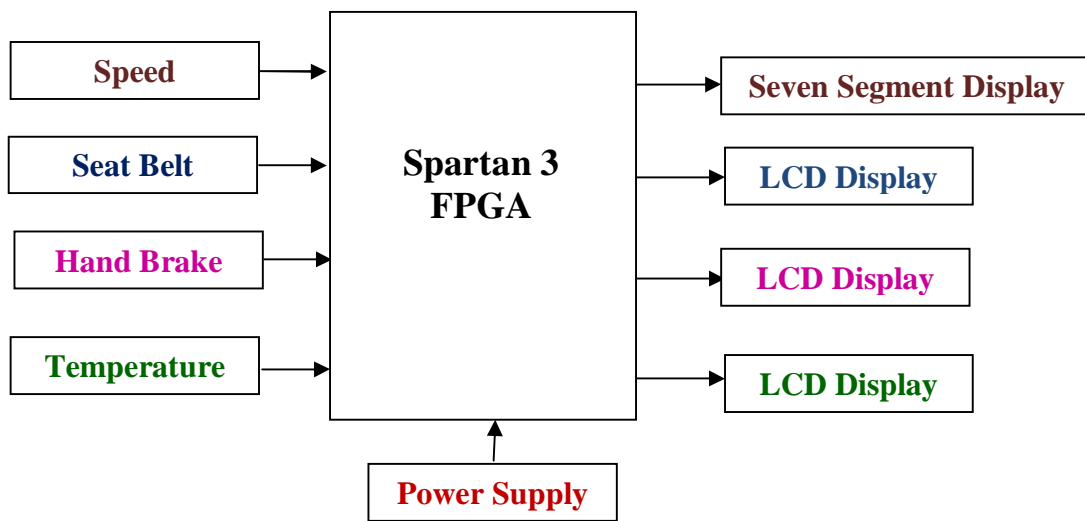


Fig 3: Functional Block Diagram of Automotive Instrumentation Display

In our design, for calculating the vehicle speed in km/hr components used are IR LED, rotating disc, and seven segment display. IR LED, rotating disc and phototransistor plays active role in the implementation. Initially power on the system. Opaque disc is fixed at the front wheel. At the edge of the disc contains equidistant holes are present. IR LED emits the signal continuously which falls on phototransistor receiver based on the disc rotation forms line of sight. Depending on the existence of the hole, phototransistor conducts. Counter counts the number of pulses based on the conduction of the phototransistor. The counted pulses represent the speed in km/hr and are indicated in the seven segment display. Range of the speed is calculated is varies from 0 to 999 km/hr.

For checking the status of the seat belt system components used is switch, FPGA board and LCD display. When switch goes high, LCD display indicates seat belt is on. When switch goes low, LCD display indicates seat belt is off.

For checking the status of the hand brake system components used is switch, FPGA and LCD display. When switch goes low, LCD display indicates hand brake is off. When switch goes high, LCD display indicates hand brake is on.

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For examining the temperature of the engine continuously components used is LM35 sensor, FPGA board and LCD display. Temperature of the engine is continuously read by the sensor. Read value is given to FPGA. Calculated appropriate temperature of the engine in °C is indicated in the LCD display.

## IV. METHODOLOGY

This methodology discusses the detailed computation of the speed, verification of status of seat belt, status of hand brake and temperature of the engine.

- In our design for calculating the speed of the vehicle, two counters are used such as M and N. M counter stores the previous values and N counter stores the current values. As pulse arrives counter increments by one step. If M counter Values are greater than N counter values then speed increases else speed decreases gradually. After calculating the speed in km/hr is shown in the seven segment display.
- Seat Belt system is designed by passing switch input either 0 or 1 to FPGA, based on the seat belt status i.e. seat belt fastening or not fastening is indicated in LCD display.
- Hand brake system uses switch input either 0 or 1 which is passed to FPGA to know the brake status i.e. whether driver applied the brake or not and is indicated in the LCD display.
- Temperature sensor LM35 reads the temperature of the engine regularly and is given to FPGA, temperature of the engine is calculated using the relationship is given below. Calculated temperature value in °C is indicated in LCD display.

$$\text{Temperature in Celsius} = (V \text{ out in mV})/10$$

## V. SEQUENCE DIAGRAM

The sequence diagram shows the sequence of message flow between the objects. Below sequence diagram represents the whole automotive instrumentation display sequential operation.

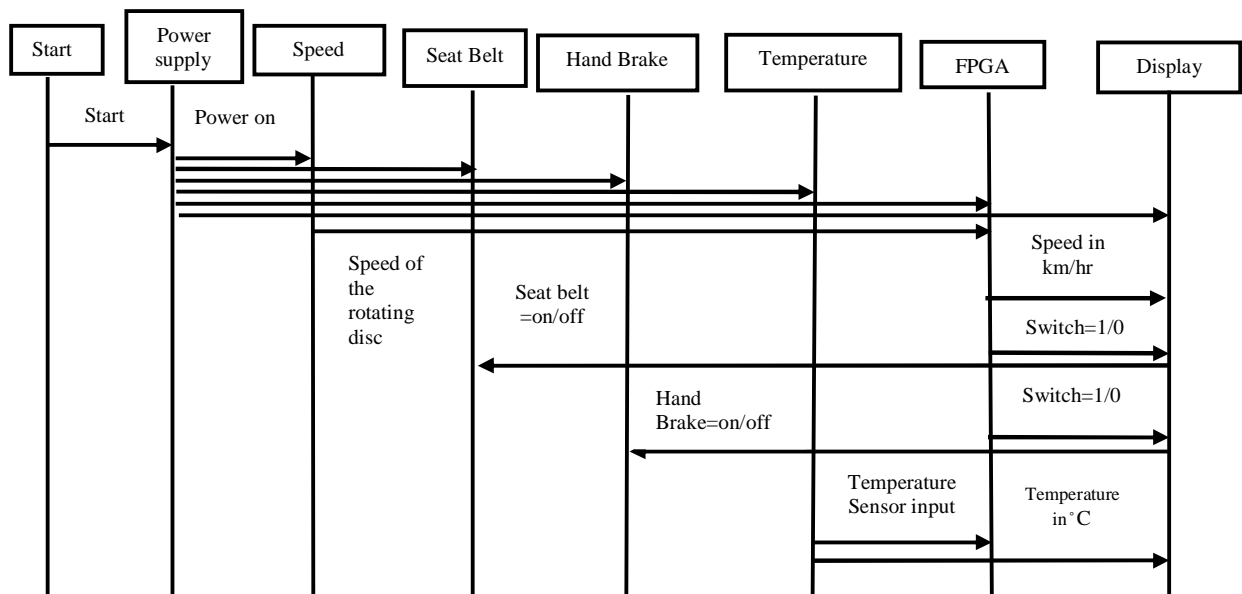


Fig 4: Sequence diagram of automotive instrumentation Display

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When the system is power on. Based on the input parameters i.e. speed, seat belt and hand brake or temperature value fed by the Occupant of the vehicle to the FPGA gives related results to take proper decision to the vehicle. The above diagram gives the overall flow of the automotive instrumentation display system.

### a) Speed system

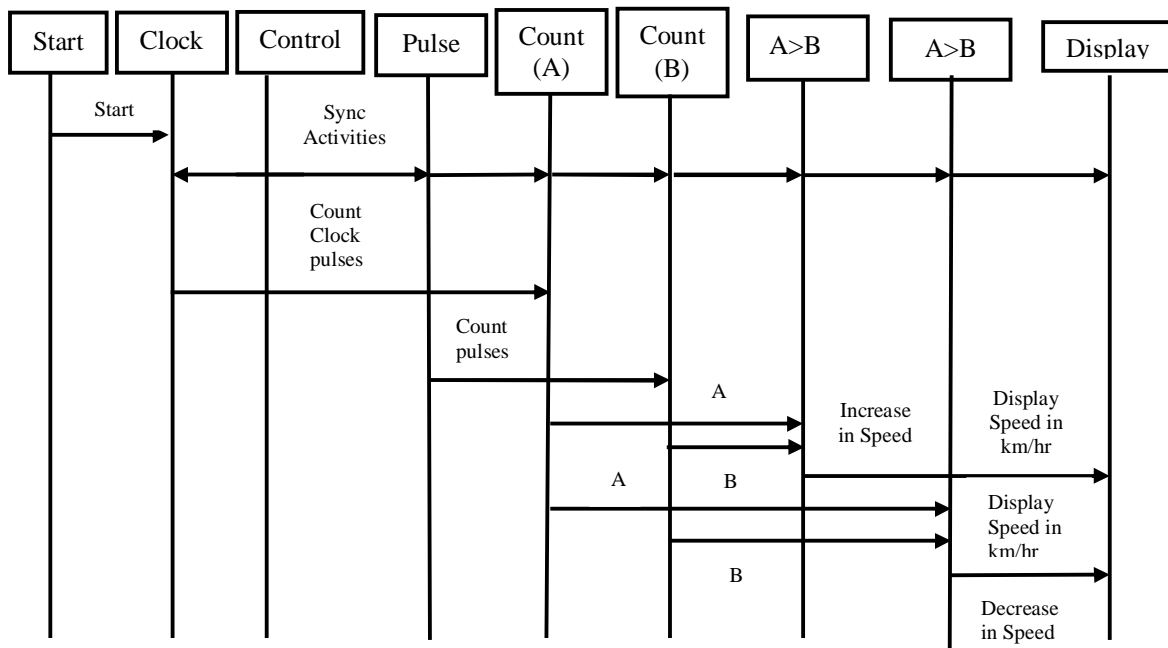


Fig. 5: Sequence Diagram of Speed System

When the system is power on. At regular intervals, clock pulses are generated. Based on the detection of the pulses, speed is estimated using FPGA by maintaining the different counters and final output is displayed for further usage. Speed is represented in Km/hr. The above figure 7 gives the detailed flow of the speed system.

### b) Seat Belt system

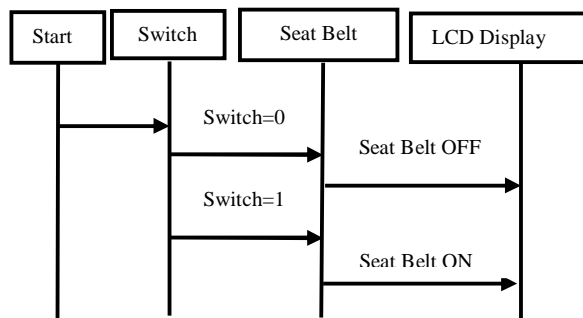


Fig 6: Sequence Diagram of Seat Belt System

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Based on the input status, FPGA processes the operation and indicates the seat belt status. Depending on the status of the seat belt is fastened or not fastens. Final result is displayed in the LCD display.

### c) Hand brake system

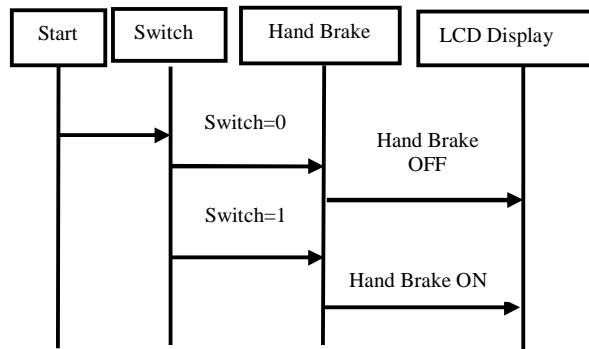


Fig 7: Sequence Diagram of Hand Brake System

Based on the input status, FPGA processes the operation and indicates the hand break status. Depending on the status of the hand break is applied or not applied. Final result is displayed in the LCD display.

### c) Temperature System

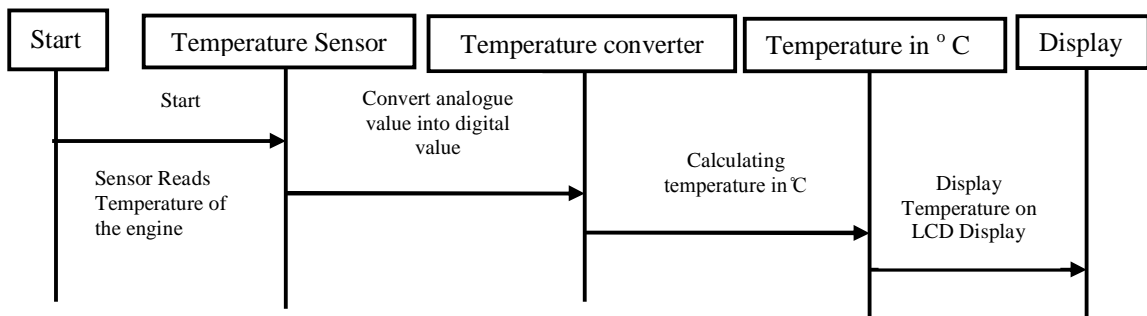


Fig 8: sequence diagram of temperature system

Temperature sensor is present in the vehicle which senses the temperature of the coolant engine and passes this information to the display. This gathered information helps in avoiding the damage to the vehicle by checking the coolant engine at regular intervals. This temperature parameter indicates the over heating or cooling effect of the engine. Figure 8 shows the detailed flow of the temperature system.

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## VI. SIMULATION RESULTS

Test results are obtained after the processing of information. Speed of the vehicle, engine temperature, status of the seat belt and brake system is gathered in terms of simulation results and depicted in the display as shown below.

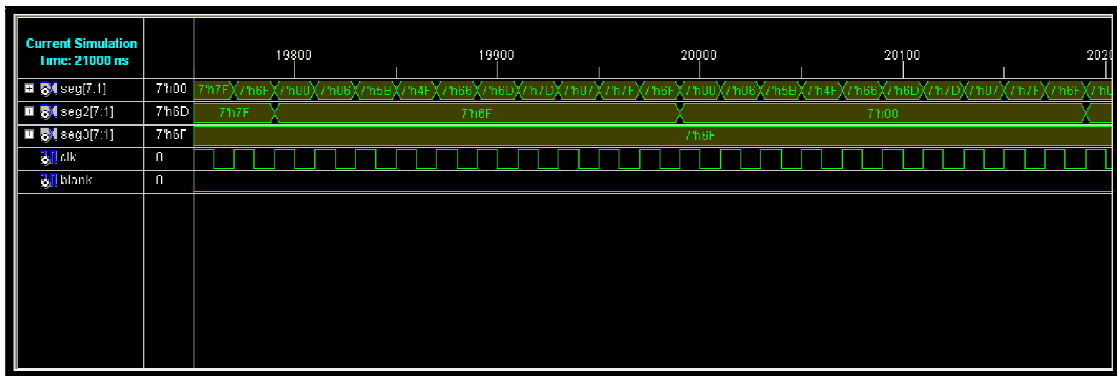


Fig. 9: Test result of Speed System

Figure 9, shows the simulation result of the speed system. Multiplexed three seven segment display shows the speed of the vehicle in km/hr.

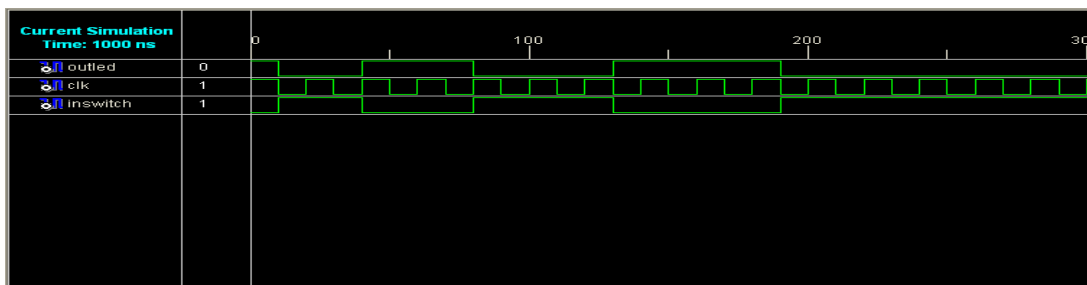


Fig. 10: Test result of Seat Belt System

Figure 10, shows the simulation result of the seat belt system. clk and Inswitch are the inputs and outled is the output parameter.

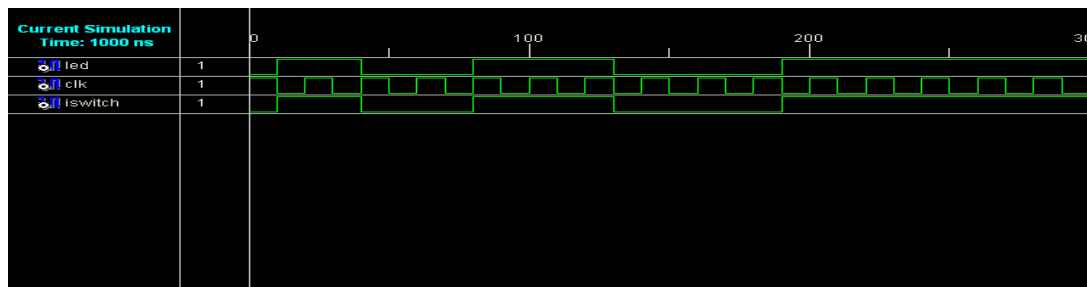


Fig. 11: Test result of Hand Brake System

Figure 11, shows the simulation result of the seat belt system. clk and iswitch are the inputs and led is the output parameter.

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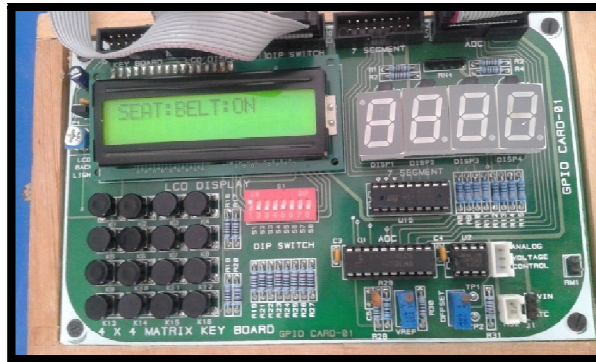


Fig. 12: Test result of Seat Belt System

Figure 12 shows the test result of the seat belt system, LCD display indicates “SEAT BELT: ON”.

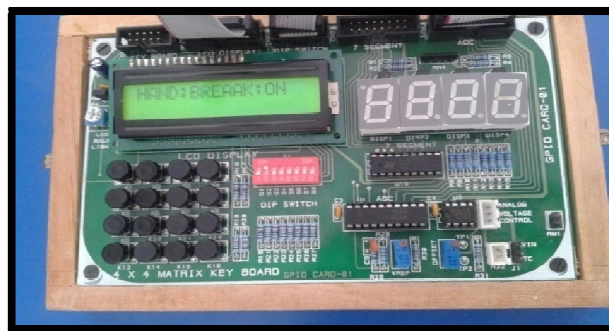


Fig. 13: Test result of Hand Brake System

Figure 13 shows the test result of the seat belt system, LCD display indicates “HAND BREAK: ON”.

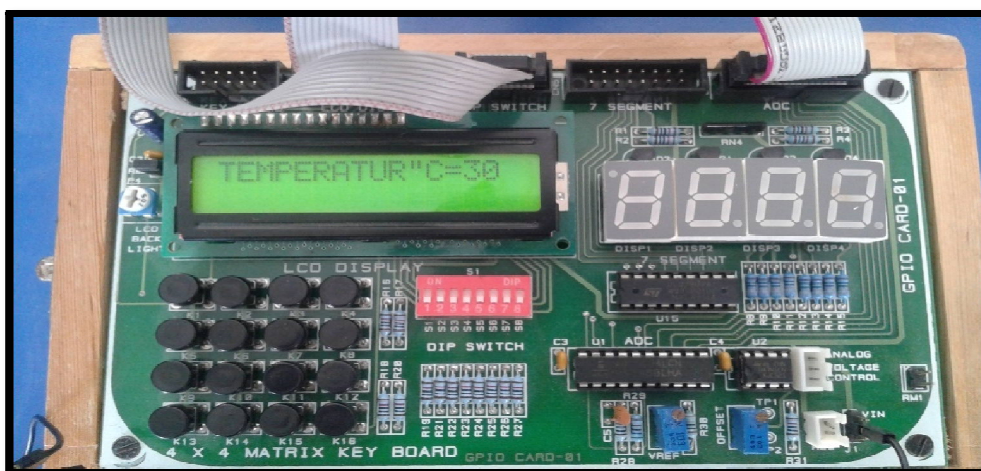


Fig. 14: Test result of Temperature System

Figure 14 shows the test result of the temperature system, calculated appropriate temperature of the engine in  $^{\circ}\text{C}$  is indicated in the LCD display. LCD display indicates the “TEMPRATURE C=30”.



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## VII. CONCLUSION

The automotive instrumentation display is designed using FPGA is widely used in automobile industry. The automotive instrumentation display guides the driver to take proper action based on the processed information to avoid untoward disaster while driving. In the real time, on requirement basis user gets the speed of the vehicle in km/hr, status of the seat belt, and hand brake information and temperature of the engine in °C to control the vehicle. Spartan 3 FPGA development board is used for realizing the design in order to get the more efficient results at higher rates. Enhancement and Scalability of the program is easier in case of FPGA. Up gradation facility is provided using the seven segment display and LCD display.

## REFERENCES

- [1] Aparajita Adhikary, Shumit Saha, Robin Sarkar, "Real time design and implementation of digital speedometer on FPGA" ,International Journal of Innovation Research Development. ISSN: 2278-0211 volume 2, issue 6, June 2013.
- [2] Amit Kumar Dimha, Vijay Kumar and John singh.K "Speed controlling using distance detector in moving vehicle", International Journal of Engineering and Computer Science. ISSN: 2319-7242 volume 2 issue, Page No.1453-1456, 5 May 2013.
- [3] G.V.Bharadwaja Sarma, CH.Nagaraju, "Automotive engine temperature control employing apt temperature measurement and control measure", International Journal Research and Applications. ISSN: 2248-9622 volume 2 issue 4, pp.1425-1429, July-August 2012.
- [4] S.D.Rahul Bharadwaj, Sharaddha R, Jagdhankar, "Seat belt safety features using sensors to protect occupant", International Review of Applied engineering Research. ISSN: 2248-9967, volume 4, pp.349-354,, 4 November 2014.
- [5] B.Devikiruba, "Vehicle speed control system using GSM/GPRS", International Journal of Computer Science and Information Technologies, ISSN: 0975-9646, volume4 (6, 983-987), 2013.