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# Applications of Embedded System in Cluster Testing

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***Abstract*— Testing of the equipment is very essential before being put into service. The testing has to be done by the latest technique. In this paper the testing of cluster that is speedometer testing, tachometer testing, temperature gauge testing, fuel gauge testing, indicator testing are discussed. The latest Microcontroller is used for pool proof testing. The program has been coded using 'C' language and testing is carried out. This testing is much superior to the conventional testing. Hence this approach of "Microcontroller based cluster testing system" is a latest one.**

***Index Terms*— Cluster, HMI, PIC, UART.**

## I. INTRODUCTION

The entire world depends on machine for everything. Any machine without control leads to danger. For controlling any machine we need some Human Machine Interface (HMI). Since HMI gives details about the working status of machine. From that data the operator can easily be able to control the machine. In all vehicles the cluster acts as HMI. It helps the driver to indicate the current speed, kilometers traveled, fuel level in tank and some other peripheral working indicators. They are helpful in controlling the vehicle. If it is not working properly then it may lead to accidents. So to avoid that we decided to design the "micro-controller based cluster test system". This will check the proper working of clusters by applying different signals at different conditions automatically. The quality department and testing department are the most important departments. Even single faulty product launched in the market may lead to series problem and bad impression on the industry. So to achieve perfection, accuracy, quicker response and perfect result we selected Microcontroller. The Microcontroller is a single chip which has ability to perform different tasks. Let us discuss this in detail.

## II. EXISTING SYSTEM

The existing system for testing the cluster is manual checking i.e., the tester has to give the inputs to each and every warning indicator individually and then only the tester checks the indicators. The tester has to give frequency inputs from the signal generator to the speedometer and tachometer to check these. The fuel gauge and temperature gauge are resistance dependence, so resistance variation should be given as inputs to these. This process takes long time and it has minimum accuracy. There are chances for occurrence of error by the device or operator and there is no proof of the test for later reference.

## III. PROPOSED SYSTEM

The proposed system uses Philips microcontroller. The warning indicators are turned ON and OFF sequentially by the controller. Giving input frequency, which is generated by the microcontrollers according to its specification frequency each, tests the speedometer and tachometer. Shorting resistance input to ground that tests the temperature gauge and the fuel gauge to its full deflection. The LCD display used in the Test system is to select the mode of operation, either automatic mode or step by step mode. It is also used to show which is under test either indicators or the gauges or the meters.

The outputs from the controller for the cluster are given to the cluster through a connector cable. By connecting the cable to each cluster input, all the indicators are checked quickly and finally if all the testes are completed properly then printout will be produced by the controller in this system in ISO format. If any error is detected the faulty part is tested again by the system and sent to clearance for rectification of fault.

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## IV. CLUSTER DESCRIPTION

Gauges provide the driver with a scaled indication of the condition of a system. Gauges that indicate a relative scale of values are known as analog instruments. Those that indicate an exact number for a measured quantity are known as digital instruments.

## V. SPEEDOMETER

The speedometer is considered as a non – electrical or mechanical gauge. The typical mechanical speedometer was connected to a gear inside the transmission by a drive cable. The drive cable was connected to a magnet inside a cup shaped metal piece. The cup is attached to Speedometer needle and held at zero by a hairspring. As the cable rotates faster due to increasing vehicle speed, magnetic forces act on the cup and force it to rotate. The speedometer needle, attached to the cup, moves up the speed scale.


**Fig 1: Cluster Meter**

Speed is determined by taking the input pulse frequency (in Hertz) and dividing by 2.2 Hertz/mph. most digital speedometer display vehicle speeds from 0 to 85 mph (199 km/h). Vehicle speed is displayed whether the vehicle is moving forward or backward.

**Table 1: Comparison of Speed Vs. Frequency**

| S.No | Actual speed | Frequency (Hz) |
|---|---|---|
| 1. | 0 | 0 |
| 2. | 20 | 27.78 |
| 3. | 40 | 55.56 |
| 4. | 60 | 83.33 |
| 5. | 80 | 111.11 |
| 6. | 100 | 138.89 |
| 7. | 120 | 166.67 |
| 8. | 140 | 194.44 |
| 9. | 160 | 222.22 |
| 10. | 180 | 250 |

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## VI. TACHOMETER

The tachometer indicates engine rpm (engine speed). The deflection of the tachometer is based on the frequency generated by the sensor. The electrical pulse to the tachometer typically comes from ignition module or PCM. The Tachometer, using a balanced coil gauge, converts these pulses to rpm that can be read. Faster the engine rotates, greater the number of pulses from the coil. Consequently greater is the indicated rpm.

**Table 2: Comparison of Indication Vs Frequency**

| S.No | Indication (rpm) | Frequency (Hz) |
|---|---|---|
| 1. | 0 | 0 |
| 2. | 1000 | 33.33 |
| 3. | 2000 | 66.67 |
| 4. | 3000 | 100.00 |
| 5. | 4000 | 133.33 |
| 6. | 5000 | 166.67 |
| 7. | 6000 | 200.00 |
| 8. | 7000 | 233.33 |
| 9. | 8000 | 266.67 |

## VII. TEMPERATURE GAUGE

This gauge indicates engine coolant temperature. The sender or sensor for temperature Gauge is usually a thermistor. It should normally indicate between 170 degF and 195 degF. Typically the maximum allowable temperature is 210 degF. The thermistor determines current flow through the temperature gauge winding. With low coolant temperature the sender resistance is high and current flow is low. As coolant temperature increases, sender resistance decreases and current flow increases.

**Table 3: Comparison of Temperature Vs Resistance**

| Temperature (in degrees) | 60 | 75 | 110 | 115 | >120 |
|---|---|---|---|---|---|
| **Resistance (in Ohms)** | >104.1 | 60.6 | 21.1 | 18.5 | 16.1 |

## VIII. FUEL GAUGE

Fuel gauge is used to show the level of fuel in the fuel tank. A bimetallic fuel gauge operates through heat created by the current flow. A variable sending unit causes different amount of current to flow through a heating coil within the gauge. The heat acts on a bimetallic spring attached to a gauge needle. When more heat is created the needle swings farther up the scale. When less heat is created the needle moves down the scale. This gauge indicates the fuel level in the fuel tank. It is a magnetic indicating system that can be found on either on analog or digital instrument panel. The fuel sender unit is mounted on the fuel pickup tube assembly and consists of a variable resistor controlled by the level of an attached float in the fuel tank. When the fuel level is low, resistance in the sender is low and movement of the gauge indicator dial or number of lit bars is minimal (from empty position). When the fuel level is high, resistance in the sender is high and movement of the gauge indicator or number of lit bars is greater.

**Table 4: Comparison of Resistance with Level of Fuel**

| Position | Empty | Warning | Half | Full |
|---|---|---|---|---|
| **Resistance (in Ohms)** | 92 | 86 | 32.5 | 10 |

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## IX. WARNING INDICATORS

The cluster consists of twenty warning indicators. These are very useful for the driver while driving. The indicators present in the cluster are

- Turn left
- Turn right
- High beam
- Battery charge
- Brake
- Oil pressure
- Low Beam

## X. MICROCONTROLLER – PIC16F73

The PIC16F73 device contains a non-volatile 64KB Flash program memory that is both parallel programmable and serial In-system and In-application Programmable. In-system programming (ISP) allows the user to download new code while the microcontroller sits in the system. This allows for remote programming over a modem link. A default serial loader (boot loader) program in ROM allows serial In-system Programming of the Flash code. For In-Application Programming, the user program erases and reprograms the flash memory by use of standard routines contained in ROM.
This device executes one machine cycle in 6 clock cycles, hence providing twice the speed of a conventional 80C51 and other microcontroller. An OTP configuration bits lets the user select conventional 12 clock timing if desired. The device is a single-chip 8-BitMicrocontroller manufactured in advanced CMOS process. The instruction set is 100% compatible than 80C51 instruction set. The device also has four 8-bit I/O ports, three 16-bit timer/event counters, a multi-source, four-priority-level, nested interrupt structure, an enhanced UART and on-chip oscillator and timing circuits. The added features of the PIC16F73 make it a powerful microcontroller for applications that require pulse width modulation, high-speed I/O and up/down counting capabilities such as motor control.

## XI. CALCULATION OF TIME PERIOD

Crystal frequency = 4MHz
Timer frequency = 1/12 * crystal frequency
= 1/12 * 4 MHz
= 0.0333 MHz
T = 1/f = 1/0.0333
T = 3 µs

## XII. SPEEDOMETER CALCULATIONS

Generating desired frequency using timer to indicate 20Km/hr
Frequency = 27.78
To find time values, T = 1/27.78 = 0.035997
T = 35.997ms
Half of T is for high and low portion pulse = 17.9985ms
17.9985/3 = 5999.5
65536-5999.5 = 59536.5
= 59536 in decimal
Hex Value of 59536 = E890

## XIII. ALGORITHM

***Main***

1. Start
2. Check for any key press
3. Initialize LCD
4. If no key press detected display self mode and perform self test.
5. Else display Manual mode and perform manual test.

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***Self mode:***

1. Start
2. Switch off all output
3. Display Self mode on LCD
4. Generate maximum frequencies for speedometer and tachometer.
5. Perform general illumination check and indicator check.
6. Switch ON temperature gauge and fuel gauge.
7. Switch OFF temperature gauge and fuel gauge.
8. if any key press detected, switch to Manual mode from that point
9. print the final report on the performance of cluster

***Manual mode:***

1. Start
2. Switch OFF all output
3. Display Manual mode on LCD
4. Check which Key is pressed.
5. If Speedometer Key is pressed, generate corresponding frequency for each input pulse.
6. If Tachometer Key is pressed, generate corresponding frequency for each input pulse.
7. If Warning indicator key is pressed, switch ON General illumination and the indicators.
8. If Fuel gauge key is pressed, switch ON corresponding outputs for each input pulse.
9. If Temperature gauge key is pressed, switch ON corresponding outputs for each input pulse.
10. If Rest key is pressed switch off all outputs and start self mode.

***(Note the coding for this testing system is given in Appendix-I)***

## XIV. ADVANTAGES

- Its efficiency is comparatively high
- It is simple in operation and construction
- The output produced is with high accuracy because all manual error has been reduced
- The operator can be easily communicated through LCD
- This system take minimum time for operation than conventional type
- In this feedback loop has been used
- The final result is produced in printout in ISO standard

## XV. DISADVANTAGES

- The special features of different clusters may not be tested using the same system we have to alter some design part based on requirement.
- We know life cycle of any electronics device is minimum. The devices and microcontroller is to be upgraded.
- To operate this system the operator should have minimum English knowledge
- Even though the system is automatic we need some man support to connect the cables and to place the cluster in the testing kit.

## XVI. CONCLUSION

As said earlier using this paper the quality department of **Pricol** industry check the performance and proper working of their product by conducting different tests by applying different signals at different conditions. and finally the output is provided in printout form as a quality certificate of the product in the international standard by considering all the conditions.

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### *APPENDIX-1*

```
#include<pic.h>
#include<ctype.h>
//Data Definition
typedef unsigned char byte;
typedef unsigned int word;
//input Pins
sbit s_ip   = P3^4;
sbit t_ip   = P3^5;
sbit w_ip = P3^0;
sbit f_ip   = P3^1;
sbit tm_ip= P3^2;
sbit rst     = P3^3;
//Output Pins
sbit s_op  = P2^4;
sbit t_op  = P1^7;
sbit gi      = P2^7;
sbit w_h  = P2^6;
sbit w_l   = P2^5;
sbit EN   = P3^7;
sbit RS    = P3^6;
sbit f_h   = P2^3;
sbit tm_h = P1^4;       //Port Access
Sfr lcd_add = 0x80;
Sfr P1_acc = 0x90;     //temperature gauge (P1^0-P1^4)
Sfr P2_acc = 0xA0;//fuel gauge (P2^0-P2^3)           //warning (P2^5-P2^7)
Sfr P3_acc = 0xB0; //switches (P3^0-P3^5) rs-p3^6 en-P3^7    //Functions
void speedo(void);
void selftest(void);
void tacho(void);
void warning(void);
void fuel(void);
void temp(void);
void reset(void);
void lcdmain(void);
void init_lcd(void);
void clr_disp(void);
void lcd_command(void);
void lcd_data(void);
void lcd_enable(void);
void selftest(void);
void tacho(void);
```

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```
void warning(void);
void fuel(void);
void temp(void);
void oneusdelay(void);
void delay_us(byte b_usec);
void onemsdelay(void);
void delay_ms(byte b_sec);
void delay_sec(byte b_sec);
//Defining Values to byte variables
#if !define(main)
Extern byte data i;
#endif
```

*MAIN PROGRAM*

```
#include "alldecl.c"
#define main
Byte data I;
Void main()
   {
      while(1)
         {
           while(P3_acc==0xff)      //if no key press go to self test mode
            {
      lcdmain();        //display self test
      delay_sec(2);
      selftest();
     delay_sec(2);
     }
while(P3_acc!=0xff)
//if any key press display manual
{
     lcdmain();
     if(s_ip==0)    //if speedo key press
      {
         lcdmain();          //display speedo
         speedo();      //goto speedo
       }
else if (t_ip == 0)        //if tacho key press
{
       lcdmain();                //display tacho
       tacho();          //goto tacho
        }
else if (w_ip == 0)             //if warning kay press
{
   lcdmain();//display warning indicators
     warning();                  //goto warning
}
else if (f_ip == 0)           //if fuel gauge key press
{
lcdmain(); //display fuel gauge
      fuel();    //goto fuel
}
else if (t_ip == 0)        //if tacho key press
```

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```
{
       lcdmain();                //display tacho
       tacho();           //goto tacho
        }
else if (t_ip == 0)        //if tacho key press
{
       lcdmain();                //display tacho
       tacho();           //goto tacho
        }

else if (tm_ip == 0)       //if temp gauge key press
{
 lcdmain();  //display temperature gauge
     temp();                  //goto temp
}
else if(rst ==0)         //if reset key press
{
     reset():       //goto reset
}
        }
    }
}
```