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Tire Pressure Monitoring and Automatic Air Filling System

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Abstract

Due to the legal situation in some states and the beneficial effects on vehicular safety, fuel consumption and comfort issues, tyre pressure monitoring systems became very popular in the recent years. Tire pressure monitoring and automatic filling system is a system being developed for use by commercial vehicles. It is an electronic system designed to monitor air pressure and temperature inside the tires and inform to driver via display. If pressure is below the desired, the compressor will re-fill the tire. .If it is above desired, excess pressure will release through a valve.

1. Introduction

The tire pressure monitoring and automatic air filling system (TPMAFS) can not only make the driver more safety, but also save fuel and protect the tire. Tire safety is attracting the driver's attention, the United States had developed laws to enforce the TPMS installation in the car. In this paper, the basic structure and the implement method, automatic filling of air are introduced. This is an electronic system designed to monitor air pressure inside the tires on various types of vehicles. This system report real time tire pressure information to the driver via a display. Proper tire inflation pressure improves fuel efficiency, reduces breaking distance, improves handling, and increases tire life, while under inflation creates overheating and can lead to accidents.

The main causes of under inflation are natural leakage, temperature changes and road hazards.The accurately measured temperature and pressure values were obtained by using SMART transmitter pressure sensor. The excellent agreement between the pressure and temperature results measured by the sensor and the direct measurement data is presented. The practical results in the certain ranges of pressure and temperature demonstrated that the micro sensor is able to measure temperature (20ºC-100ºC) and pressure (0kPsi- 150Psi) at the same time.

2. Related Works

This system based on tyre pressure monitoring systems (TPMS)[1], which are in widespread commercial use due to legal situations and their positive impact on vehicular comfort and safety standards, advanced tyre monitoring systems (ATMS) are currently under investigation. Pressure sensor is used to measure pressure inside the tyre. Measured pressure is informed to driver via a display. This model can use only in commercialvehicle

Both, TPMS and ATMS rely on sensor equipped wheel units (WUs), which use radio transmissions to transfer measurement data. While the WU of conventional direct TPMS is mounted in the rim and often uses the valve's protruding part as antenna, the WU of an ATMS is placed directly in the tyre. This mounting enables to gain new sensor data like tyre tread vibration, vertical load and contact area. Additionally, radio frequency identification (RFID) functionality can be implemented. A requirement for this mounting position is a light-weight WU, so it should be battery-less. To power the WU of an advanced tyre monitoring system,the electromagnetic field of the centralised on-board unit (OU) could be used like in passive RFID systems. So the radio propagation channel for ATMS is not only important for data transfer, but should also be analysed for the purpose of WU powering. To retrieve accurate channel measurement data, a special mounting method of the wheel under investigation, and de-embedding of cable and antenna mismatching losses are used. The measurement results for both frequency bands indicate multi-path propagation with fading up to 30 dB. For three of four antenna orientations a dominating path component is identified in the channel's phase response, for which the resulting dominant Doppler frequency was derived. With the presented measurement results we demonstrated that the channel's magnitude, phase response and antenna mismatching are highly influenced by WU antenna mounting.

In this system[2], place pressure sensors inside the tire at the base of the tire valve stem. The sensors include a battery and signal the driver via a radio transmitter when low pressure is detected. Used in hi-end vehicles. The temperature sensor used to measure the temperature on tyre. A small electronic module housed in the inflation valve of each wheel permanently monitors the tyre. It contains a pressure sensor, a temperature sensor and a radio transmitter. A lithium battery, also included in the electronic module, provides ten years of autonomy. Every minute, by means of a short radio burst, the module transmits the values from the sensors to a computer on-board the vehicle. It correlates this data with other data, such as the wheel rotation speed and acceleration, to detect any anomaly. A loss of pressure, an imbalance in pressure between the wheels, or over- or under-inflation immediately triggers a warning which specifies the type of anomaly and the wheel concerned. Of course, the "radio dialogue" between the wheels and the onboard computer occurs in coded digital form, to eliminate any risk of interaction with any other nearby vehicle also fitted with a tyre pressure monitoring system.

Here, In the tire pressure monitoring and automatic air filling system report real time tire pressure information to the driver via a display. Tire Pressure Monitor (TPM) portion of design which is comprised of sensors. The sensors on each tire physically measure the tire pressure and temperature. Proper tire inflation pressure improves fuel economy, reduces braking distance, improves handling, and increases tire life, while under inflation creates overheating and can lead to accidents. The main causes of under inflation are natural leakage, temperature changes, and road hazards. The accurately measured temperature and pressure values were obtained by using SMART transmitter pressure sensor.

3. Problem Domain

TPMS system uses only in small end vehicles and automatic air filling is not considered. The tire pressure monitoring and automatic air filling system can also use both in small-end and high-end vehicles. Automatic air filling, when pressure is below desired value, is also included with this system. This system will re-fill the pressure on tyres. The tire pressure monitoring system (TPMS) can not only make the driver more safety, but also save fuel and protect the tire.

4. Motivation

Tire pressure monitoring and automatic filling system provide automatic air filling into the tire when air pressure inside the tire becomes low. There occur many traffic accidents due to the malfunction of tyres that can reduced by continuous pressure monitoring. Fuel efficiency decreases due to rolling resistance. We can avoid these problems by using tyre pressure monitoring and automatic air filling system.

6. Circuit Block Diagram Explanation

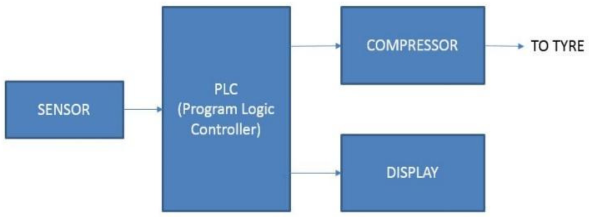


Fig VI-a

The circuit block diagram of TPMAFS is shown in fig. VI-a.SMART transduser measures temperature and pressure inside the tyre, that convert temperature and pressure values into corresponding current. The output is given to the Program Logic Controller (PLC), that control the entire system. This system report real time tire pressure information to the driver via a display. If the pressure level become below the normal level, compressure will start to fill the air into the tyre.

SMAR Transducer:

Smart Pressure Transmitter (fig VI-b) is a microprocessor-based high performance transmitter, which has flexible pressure calibration, push button configuration, and programmable using HART® Communication. The multi-planar design simplifies installation, saving operator time and money during set up. The input section comprises the process sensor or transducer and the Analog to Digital Converter (ADC). The sensor measures the process variable of interest (be it pressure, temperature, flow etc) which is then converted into a proportional electrical signal. The measured electrical signal is then transformed to a digital count by the Analog to Digital Converter (ADC). This digital count, representative of the process variable (PV), is then fed into the conversion section which contains the microprocessor. A field calibrator is not required for configuration. The transmitter software compensates for thermal effects, improving performance. EEPROM stores configuration settings and stores sensor correction coefficients in the event of shutdowns or power loss. The Series 3100MP is FM and ATEX approved for use in hazardous (classified) locations. The 100:1 rangeability allows the smart transmitter to be configured to fit any application.

Service: Compatible gases, steam, liquids or vapors.

Accuracy: ±0.075%

Rangeability: 100:1

Stability: ±0.125%

TemperatureLimits:

Process: -40 to 248°F (-40 to 120°C); Ambient: Without LCD: -40 to 185°F (-40 to 85°C); With LCD: -22 to 176°F (-30 to 80°C).

Pressure Limits: Max. pressure: Range:

-14.5 to 2000psi; Burst pressure: 10000psi.

Thermal Effect: ±0.125% span/32°C

Power Requirements: 11.9 to 45 VDC.

fig. VI-b SMART transducer

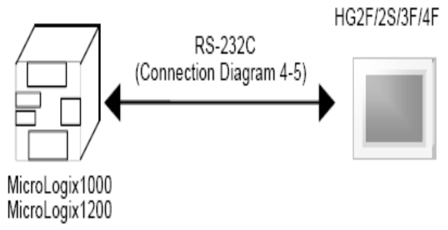
B. Thermister:

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of *thermal* and *resistor*. Thermistors are widely used as in rush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range, typically –90 °C to 130 °C.

C. Program Logic Controller:

A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a *hard* real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

Allen Bradley Micrologix PLC using Micrologix/SLC 500 (Full Duplex) protocol. For other supported Allen Bradley PLCs and communication settings/range of addresses, please refer to WindO/I-NV2 manual. Select "Host Interface," then select Connection to a PLC.



Cable Part Number: HG9Z-2C135A (Between Micrologix To HG2F/3F/4F)

D. Pressure gauge:

Pressure gauges and switches are among the most often used instruments in a plant. But because of their great numbers, attention to maintenance--and reliability--can be compromised. As a consequence, it is not uncommon in older plants to see many gauges and switches out of service. This is unfortunate because, if a plant is operated with a failed pressure switch, the safety of the plant may be compromised. Conversely, if a plant can operate safely while a gauge is defective, it shows that the gauge was not needed in the first place. Therefore, one goal of good process instrumentation design is to install fewer but more useful and more reliable pressure gauges and switches.

One way to reduce the number of gauges in a plant is to stop installing them on the basis of habit (such as placing a pressure gauge on the discharge of every pump). Instead, review the need for each device individually. During the review one should ask: "What will I do with the reading of this gauge?" and install one only if there is a logical answer to the question. If a gauge only indicates that a pump is running, it is not needed, since one can hear and see that. If the gauge indicates the pressure (or pressure drop) in the process, that information is valuable only if one can do something about it (like cleaning a filter); otherwise it is useless. If one approaches the specification of pressure gauges with this mentality, the number of gauges used will be reduced. If a plant uses fewer, better gauges, reliability will increase.

Pressure Gauge Designs:

Two common reasons for gauge (and switch) failure are pipe vibration and water condensation, which in colder climates can freeze and damage the gauge housing. Figure 1 illustrates the design of both a traditional and a more reliable, "filled" pressure gauge. The delicate links, pivots, and pinions of a traditional gauge are sensitive to both condensation and vibration. The life of the filled gauge is longer, not only because it has fewer moving parts, but because its housing is filled with a viscous oil. This oil filling is beneficial not only because it dampens pointer vibration, but also because it leaves no room for humid ambient air to enter. As a result, water cannot condense and accumulate. Available gauge features include illuminated dials and digital readouts for better visibility ,temperature compensation to correct for ambient temperature variation, differential gauges for differential pressures, and duplex gauges for dual pressure indication on the same dial. Pressure gauges are classified according to their precision, from grade 4A (permissible error of 0.1% of span) to grade D (5% error).

E .Compressor:

A gas compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

7. Experimentation

1. Smart Pressure Transducer:

Input : pressure(0 to 50 psi)

Process: convert pressure to current

Output: analog signal (4mA to 20mA)

2. Thermister:

Input: temperature (-90^{0}c to 130^{0}c) Process: temperature to current Output: analog signal

1Micro Logix 1000 Analog Plc:
Input1: analog signal (4mA to 20mA)
Process: controlling
Output: digital signal

2.Compressor:
Input: signal from PLC Process: air filling
Output: pressure variation

8. Result

Tire pressure monitoring and automatic air filling system is a ke in reduction of accidents due under inflated tires. Tire is filled by turning on compressor only if the pressure inside the tire become less than the desired value. If the tire is filled with air above a particular value the compressor turned off and excess pressure release through a valve. All these processes were controlled by PLC. Also the temperature on each tire is measured using thermistors. Abnormal temperatures and pressure values were informed to the driver via display

9. Future Work and Conclusion

Any tire pressure monitoring system will work effectively if and only if the right sensors are fitted into a tire. The lack in standardization of manufacturing and delivering of such sensor-fitted tires poses a big problem. Air bag systems works using compressors. By using high speed compressor and implementing crash sensors with this system airbag system can be developed in future. By applying tire pressure monitoring and automatic air filling system properly it is easy for the driver to monitor the pressure and temperature on each tire. Tire’s inflation pressure is always under check and is maintained at a standard level, as stated by the manufacturer by using TPMAFS. Using this system gives safety of drivers and passengers become a forefront benefit, fuel efficiency is improved by having standard tire pressure and helps to avoid accidents caused with low inflated tires.

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