TYRE PRESSURE MONITORING AND COMMUNICATING ANTENNA IN THE VEHICULAR SYSTEMS

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ABSTRACT

Modern vehicles are coming with advanced gadgets and luxurious inbuilt devices. Satellite audio radio communication devices, Tyre pressure monitoring systems, accident avoidance systems, weather reports, route maps etc. Tyre pressure monitoring system gives the indication and assurance to the driver that the Tyres are operating at their expectations. The vehicle handling characteristics will be affected if the Tyre pressure is low and which may causes the accidents. The Tyre pressure monitoring system with the support of antenna, sensor, control unit and indicators will help the driver to know the condition of the Tyre instantly and avoid so many problems and issues related to this. The radio transmitters with the help of sensors will provide the alarm or any indication to the driver regarding the Tyre pressure. This present paper carries the design and simulation of compact patch antenna for the communication purpose related to these things. The complete simulation of the antenna is carried out by HFSS.

KEYWORDS: *Tyre pressure Monitoring System (TPMS), Sensors, Accident avoidance systems.*

I. INTRODUCTION

TPMS systems measure the actual Tyre pressure using sensors which incorporate radio tranmitters. The radio signals are picked up by a receiver unit which provides an alarm signal to the driver. Various types of information can be provided for the driver (alarm lamp, actual pressure, audible alarm, voice), and the sensors are either internally wheel mounted or may be externally fitted on the Tyre valve in place of the valve cap [1-3].

More advanced TPMS show the actual Tyre pressure on a display/receiver unit inside the vehicle. Actual Tyre pressure is measured by miniature sensors in each wheel which each transmit an encoded radio signal. The receiver/display is a digital back-lit display unit which recognizes your vehicle's pre-coded radio signals and sounds an alarm at high or low pressure conditions. Some also indicate and monitor Tyre temperature. Most work with no external aerial fitted to the receiver, others require an aerial laid along the car underbody. Models are available for various types of vehicle (2 wheeled, 4 / 5 / 6 wheeled, or even 24 wheeled installations. For the motorcyclist simple operation and weather proofing is more important. For the car user, style may be important. Some TPMS wheel sensors transmit adverse pressure conditions immediately, others that power off when parked only wake-up after the vehicle has achieved a minimum speed (usually 15 mph). For the racing specialist, RS232 links are available to enable conditions to be sent via computer telemetry to the pit [4-7].

The receiver/display typically require either a 12v or 24v DC supply, usually switched with the ignition. Options include combined Display and Receiver, or separate Display Module and Receiver Module with interconnecting cord [8-9].

The TPM system consists of the following major component.

- Sensor/Transmitter Device
- RF Receiver Module with Antenna
- Low-Frequency (LF) Commander Device
- Control Unit
- Pressure Vessel (Tyre)

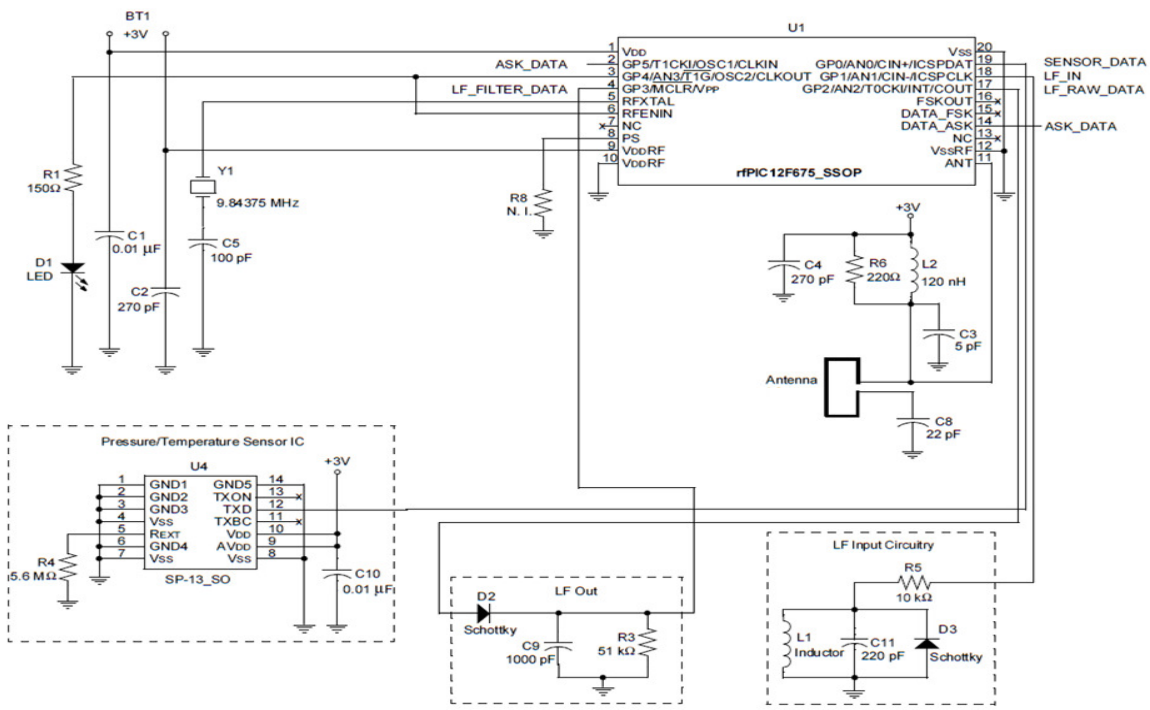

Figure (1) Tyre Pressure Monitoring system schematic diagram

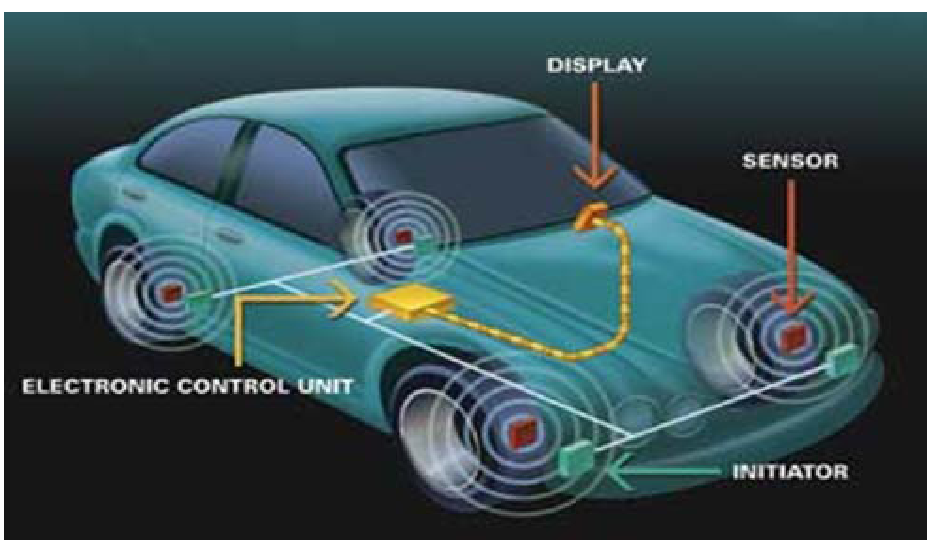

Figure (2) TPMS fixed at car Tyre

The TPM system primarily monitors the internal temperature and pressure of an automobile's Tyre. An auto-location system can dynamically detect the position of a specific sensor, which is useful when Tyres are rotated [10]. The heart of the TPM system is the Sensor/Transmitter (S/TX) device and it is based on the Microchip.

Figure (1) shows the circuitry for complete schematic of the Tyre pressure monitoring system. Figure (2) shows the Tyre pressure monitoring system fixed car Tyre overview. We are concentrated in the design of antenna for transmission purpose of sensor data and its processing. A typical compact low profile antenna was designed and simulated using Ansoft HFSS software and the antenna output parameters are presented in this paper. Moreover from the simulation results the applicability of the antenna was estimated. This antenna can be used to pass the signals regarding the Tyre pressure to nearest automobile workshops so that to alert the people to solve the problem in lesser time.

II. SIMULATION RESULTS AND DISCUSSION

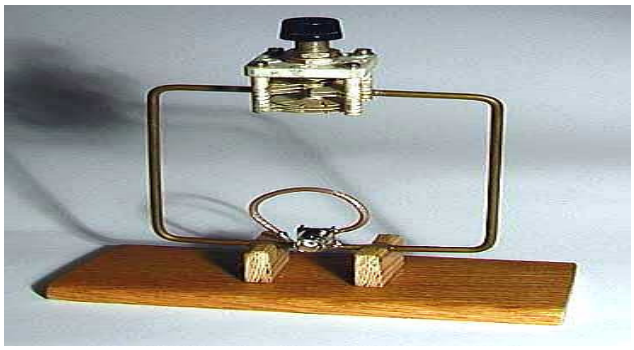

Figure (3) Loop Antenna Model

The Tyre pressure monitoring system communication antenna will work at 435 MHz. Figure (3) shows the Loop antenna model. Figure (4) shows the return loss curve for the loop antenna at 435 MHz and a Return loss of -15.45dB is obtained at desired frequency.

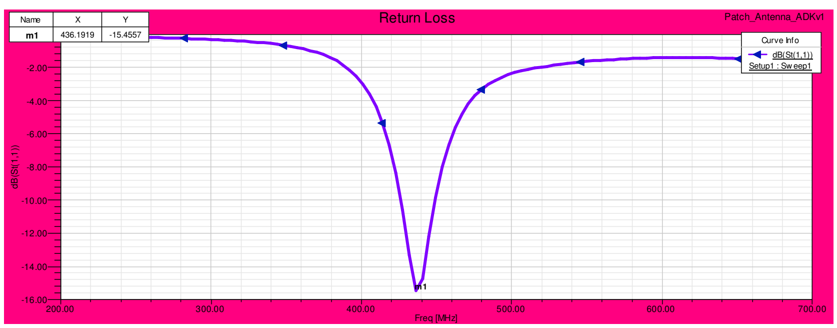

Figure (4) Return Loss Vs Frequency

Figure (5) shows the Input impedance smith chart for the antenna. Rms of 0.822 and input impedance bandwidth of 0.92% is achieved from the current model.

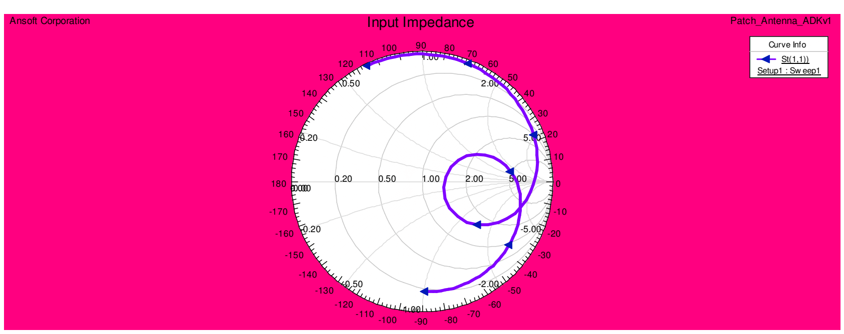

Figure (5) Input Impedance Smith Chart

Figure (6) shows the two dimensional gain curve for the antenna. Maximum gain of 8dB can be attained from the current model and it shown in the figure (6).

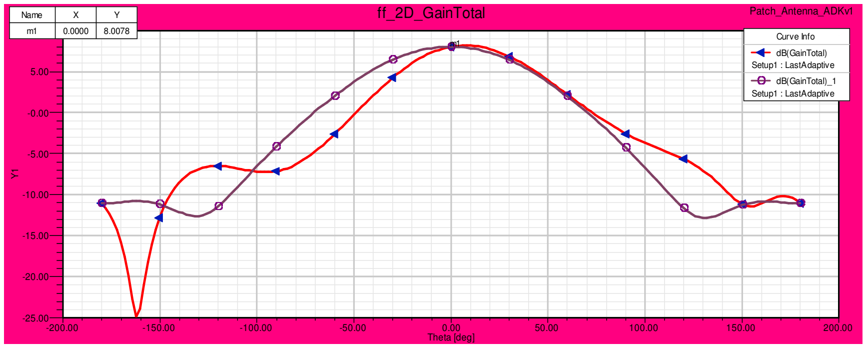

Figure (6) 2D-Gain

Figure (7) shows the VSWR Vs frequency curve and it is showing the VSWR of 1.408 at desired frequency. The current result maintains the 2:1 ratio of VSWR as per the standards. These results showing the applicability of this antenna for the proposed operation.

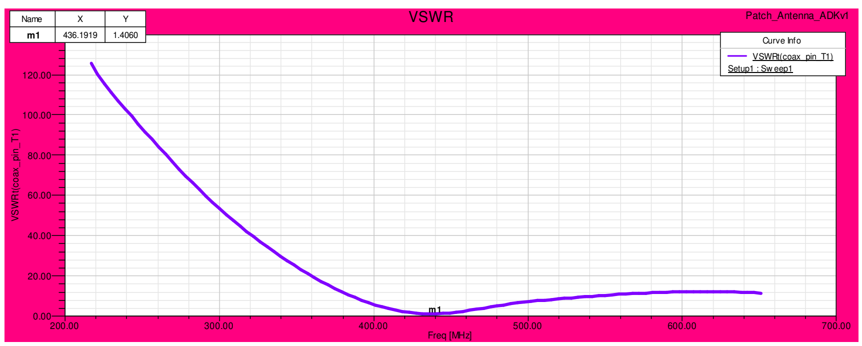

Figure (7) VSWR Vs Frequency

Figure (8) and (9) shows the radiation pattern of the antenna. The far-zone electric field lies in the E-plane and far-zone magnetic field lies in the H-plane. The patterns in these planes are referred to as the E and H plane patterns respectively. Figure (8) shows the radiation pattern of E-plane(y-z plane) in 3-Dimensional view. Figure (9) shows the radiation pattern of H-plane(x-z plane) in 3-Dimensional view.

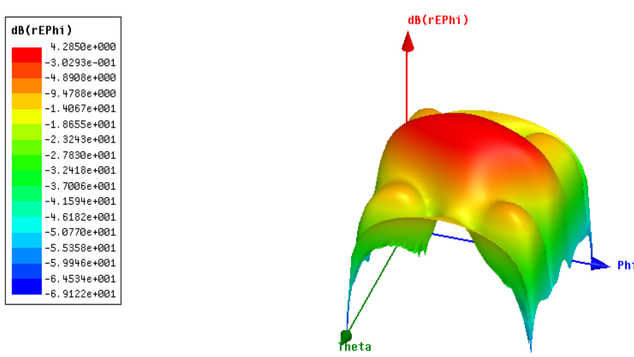

Figure (8) Radiation pattern in Phi direction

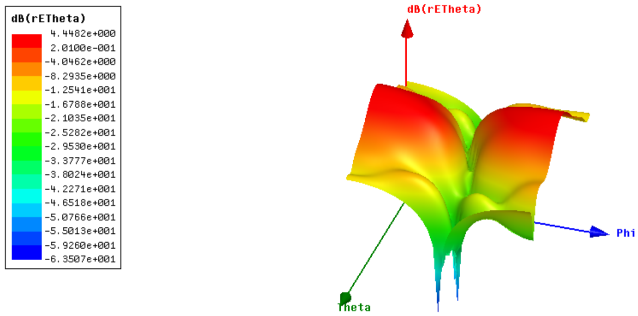

Figure (9) Radiation pattern in Theta direction

Figure (10) is giving polarization plot of the antenna in three dimensional view. The axial ratio is a parameter which measures the purity of the circularly polarized wave. The axial ratio will be larger than unity when the frequency deviates from f0. Figure (11) shows the axial ratio for the current model in 3-Dimensional view.

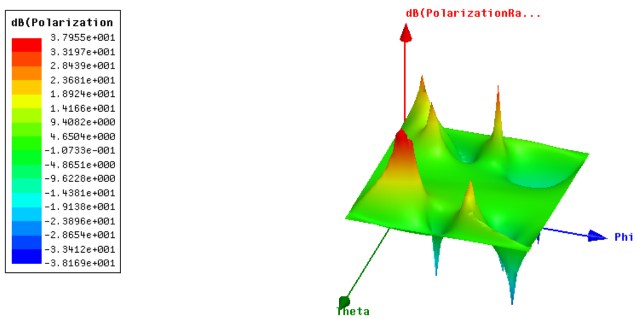

Figure (10) Polarization ratio

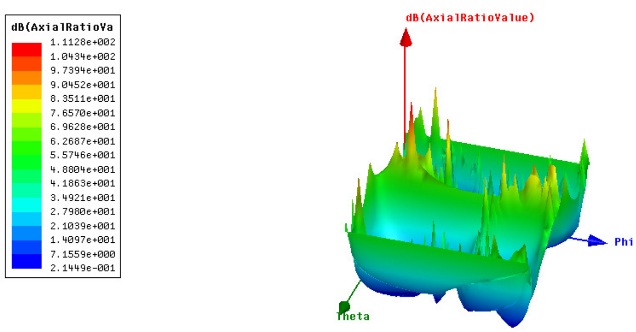

Figure (11) Axial Ratio

Table (1) and Table (2) giving the antenna parameters and maximum field data. From the table (1) it is clear that the antenna is having peak gain of 6.5dB and radiation efficiency is about nearer to one. The table (2) showing the antenna maximum field data with respect to x, y and z coordinates. The LHCP and RHCP is also presented in this work for the proposed antenna. All the values are showing good agreement with the expected values and which gives the applicability of this antenna in the real time system.

Quantity	Value/units
Max U	0.0036936 W/sr
Peak directivity	6.5839
Peak gain	6.563
Peak realized gain	6.346
Radiated power	0.00705
Accepted power	0.00707
Incident power	0.00731
Radiated efficiency	0.99683
Front to back ratio	177.07

Table (1) Antenna Parameters

rE field	Value (v)	At Phi (degrees)	At Theta (degrees)
Total	1.6688	0	8
X	1.6585	0	6
Y	0.2444	55	34
Z	0.7984	180	-44
Phi	1.6378	90	0
Theta	1.6688	0	8
LHCP	1.1912	35	10
RHCP	1.1885	145	-10

Table (2) Maximum Field data

III. CONCLUSION

Tyre pressure monitoring system based antenna was simulated at 435 MHz and the results are presented in this work. If we need stronger signal from our Tyre pressure sensors we can add booster antenna to the receiver station. Also we can bring our antenna outside the car and this will allow us to place the controller board anywhere in the car. Unlike regular wire on our controller the TPMS antenna projects the signal horizontally disregarding any other signals on different altitude and as result we see stronger and much clear noise free transmission. Two types of arrangements can be done while fitting these antennas. One is to be connected externally mounted on the top of the vehicle where signal is not being blocked by metal walls and another can be connected in the interior of the vehicle to improve the reception of the Tyre pressure USB unit. The second type is fitted inside the vehicle and transmits the signal with the help of the sensor and communication devices.

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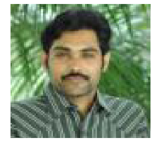
Authors Biography:



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