ANALYSIS OF ELECTROMAGNETIC INTERFERENCE IN PRESSURE SENSOR USING MICROSTRIP LOW PASS FILTER

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Abstract: In recent days the importance of "Vehicle Electronics" and the challenges in this area has been a subject of interest in the core area of safety. The Tyre Pressure Monitoring System (TPMS) is used to monitor the level of pressure in the tyres of the vehicles. The target of Tyre Pressure Monitoring System is to avoid accidents and increase tyre wear due to low tyre pressure, through early recognition of hazardous state of tyres. The tyre pressure monitoring system reports real time tyre pressure information to the driver via a simple low pressure warning light. The Brake Calliper, Control arm, large metal in the vehicle acts as a source of Electromagnetic Interference .The Electromagnetic field produced around the large metal, brake calliper, control arm interferes with the signal from the pressure sensor in Tyre Pressure Monitoring System. Resulting in false alarm to the dash board. In order to protect from the electromagnetic signal which is interfering with the signal from pressure sensor a Microstrip Low Pass Filter is designed using HFSS.

Keywords: Microstrip Low Pass Filter, ANSYS HFSS, Electromagnetic Interference, Pressure Sensor, Tyre Pressure Monitoring System, EMI.

I. Introduction

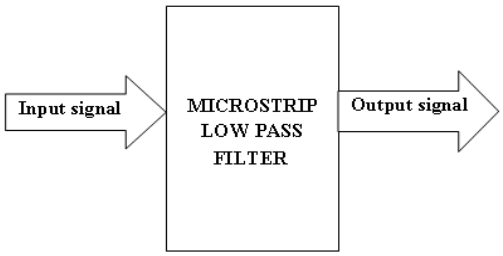
This paper investigates the Analysis of Electromagnetic Interference in Pressure sensor using Microstrip Low Pass Filter. Filter represent a class of electronic filter designed to operate on signals in the medium frequency to extremely high frequency. The frequency range is the range used by most wireless communication. Low Pass Filter allow frequencies below cut-off frequency. Therefore the Microstrip Low Pass Filter removes the Electromagnetic Signal from the signal from pressure sensor. A Tyre Pressure Monitoring System is an electronic system designed to monitor the air pressure inside the tyres on various types of vehicles. TPMS report real time pressure information to driver via a simple low pressure warning light. The Brake Calliper, control arm and large metal act as a source of electromagnetic field interferes with signal from pressure sensor. Electromagnetic interference is an unwanted or undesired signal that influences the normal operation of the system, leading to the malfunction of the system. It is also known as Radio frequency interference. It is a phenomenon where one electromagnetic field interferes with another resulting in the distortion of both fields. This interference can be reduced by using Microstrip Low Pass Filter. Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology and is used to convey microwave frequency signals. It consists of a conducting strip separated from a ground plane by a dielectric layer known as substrate. A Microstrip filter represents a class of electronic filter designed to operate on signals in the megahertz to gigahertz frequency ranges. This range is used by most wireless communication and thus most RF and microwave devices will include some kind of filtering on the signals transmitted or received.

II. Existed System

As far back as 1970,the U.S.National Highway Traffic Safety administration looked into the benefits of low tyre pressure warning equipment. In the 1970s,an Indian State University suggested that the Under-inflated tyres were the cause of 1.5% of all motor vehicles crashes, because tires low on pressure hamper handling and braking on dry and wet roads. But the early 1980s,tyre pressure sensor technology had advanced somewhat, but equipment was still not reliable or accurate enough for prime time. The U.S. congress passed the Tire Recall Enhancement, accountability and Documentation Act of 2000.That act mandated that all the passenger vehicles weighing under 10,000 pounds sold in the U.S. as of September 1,2007 be equipped with a tyre pressure monitoring system that warns drives if any of the tyres on the vehicles are under flatted by 25% or more. In the present market the Tyre Pressure Monitoring Systems are popular. For this systems there is a chance for low accuracy. To overcome this challenge we need a highly accurate and securable system. The Tyre Pressure Monitoring System may get affected due to Electromagnetic Interference. The brake calliper, control arm, large metal acts as a source of electromagnetic field. The constant rotation of the wheel, the metallic wheel structure, electromagnetic interference are the factors that will negatively impact the performance of an active TPMS using RF communication Technology. The electromagnetic field produced around the metallic wheel may interfere with the signal from pressure sensor results in decreasing the efficiency of the system.

III. Proposed System

The proposed system consists of a Microstrip Low Pass Filters. This filter is essential to reduce the influence of radiation. The pressure sensor is protected using Microstrip Low Pass Filter. The Low pass filter allows the Low frequency signals through it and blocks the high frequency signals. A Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology and is used to convey microwave frequency signals. It consists of a conducting strip separated from a ground plane by a dielectric layer known as substrate. This Microstrip Low Pass Filter removes the electromagnetic signal from the signal from pressure sensor.



IV. Design of Microstrip Low Pass Filter

A Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology and is used to convey microwave frequency signals. A Microstrip filter represents a class of electronic filter designed to operate on the signals in the range of megahertz to gigahertz. A Microstrip filter is designed in two steps. The first step is to select suitable low pass filter prototype. The selection type of response will depend on required specification. It includes pass band ripple and scalar of reactive elements. The element value of low pass filter, which are normalized to made a source impedance g0 =1 and a cutoff frequency Ωc=1.0 are then converted to L-C elements for cutoff frequency and source impedance which we usually take as 50 ohms for Microstrip Low Pass Filter. Second step is to gain an appropriate microstrip realization to the lumped element filter. The filter is fabricated on substrate of dielectric constant εr and angular thickness h mm. The Microstrip Low Pass Filter is designed and simulated using ANSYS HFSS. Design a ninth-order low pass filter with 0.1dB ripple and cutoff frequency of 1GHz.The source/load impedance of the filter is 50ohms.

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Design characteristics of Low Pass Filter

Cut-off frequency=1GHz

Source impedance=50 Ohms

Dielectric constant of substrate=4.4

Substrate thickness=0.5mm

Pass band Ripple=0.1dB

TABLE 1: Element values for low pass filter prototype

M	g1	g2	g3	g4	g5	g6	g7	g8	g9
1	2.000								
2	1.41421	1.41421							
3	1.00000	2.00000	1.00000						
4	0.76537	1.84776	1.84776	0.76537					
5	0.61803	1.61803	2.00000	1.61803	0.61803				
6	0.51764	1.41421	1.93185	1.93185	1.41421	0.51764			
7	0.44504	1.24698	1.80194	2.00000	1.80194	1.24698	0.44504		
8	0.39018	1.11114	1.66294	1.96157	1.96157	1.66294	1.11114	0.39018	
9	0.3473	1.0000	1.5321	1.8794	2.00000	1.8794	1.5321	1.00000	0.3473

From the table prototype element values are

g1=0.3473
g2=1.0000
g3=1.5321
g4=1.8794
g5=2.0000
g6=1.8794
g7=1.5321
g8=1.0000
g9=0.3473

Inductor and Capacitor values can be calculated by using the following formulas

$Li=\frac{z_0}{g_0}\times\frac{\Omega c}{2\pi fc}\times g_i$ (1)

$Ci=\frac{g_0}{z_0}\times\frac{\Omega c}{2\pi fc}\times g_i$ (2)

TABLE2: calculated lumped element values

prototype element values	corresponding L and C values
g1	C1=1.1pF
g2	L2=7.9577nH
g3	C3=4.9pF
g4	L4=14.9nH
g5	C5=6.4pF
g6	L6=14.9nH
g7	C7=4.9pF
g8	L8=7.9577nH
g9	C9=1.1pF

Characteristic impedance of high impedance line value ZoH=90ohms

Characteristic impedance of low impedance line value ZoL=25ohms

We are going to use FR4 Epoxy as substrate which has 4.4 dielectric permittivity,thickness of substrate is h=0.5mm.Now we have to calculate width and length for Microstrip filter.we can calculate width of microstrip line by equations.Equations for calculation of width and length are as given below

If $\frac{W_0}{h}=\frac{8\exp(A)}{\exp(2A)-2}$ (3)

Where $A=\frac{z_0}{60}\sqrt{\frac{\varepsilon r+1}{2}}+\frac{\varepsilon r+1}{\varepsilon r-1}$ (4)

Guided wavelength $\lambda gl=\frac{300}{f\sqrt{\varepsilon reff}}$ (5)

For calculation of physical length

$lL=\frac{\lambda gl}{60}\times\sin^{-1}\left(\frac{WcLi}{Z0L}\right)$ (6)

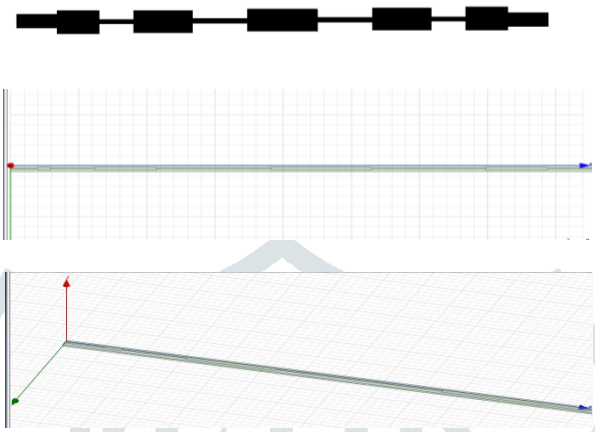
$lL=\frac{\lambda gl}{60}\times\sin^{-1}(wcCiZoc)$ (7)

TABLE 3:Lengths and widths of the elements

Elements	Length	Width
Impedance 50ohms	10	0.5626
C1	4.4919	1.2560
L2	16.3217	0.1542
C3	22.7199	1.2560
L4	41.9236	0.1542
C5	36.8974	1.2560
L6	41.9236	0.1542

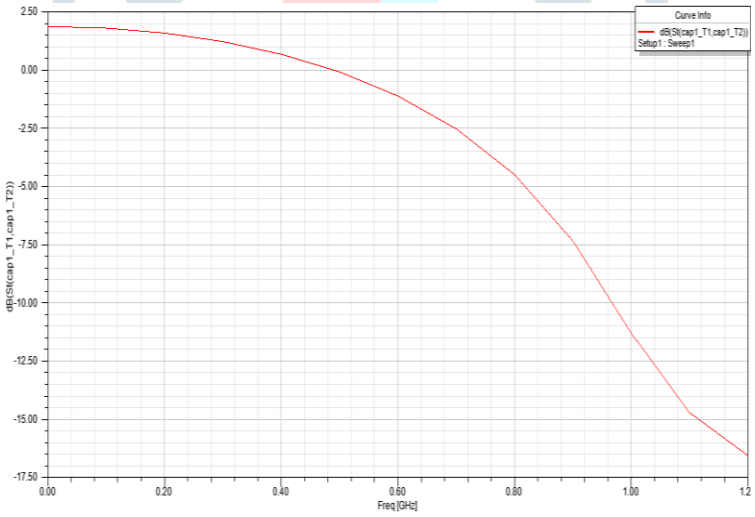
C7	22.7199	1.2560
L8	16.3217	0.1542
C9	4.4919	1.2560
Impedance 50ohms	10	0.5626

Design of Microstrip Low Pass Filter



V. Result

The simulation result of Microstrip Low pass filter is designed using ANSYS HFSS. The filter allows frequency which is less than 1GHz.Therefore it removes the unwanted electromagnetic signals.



VI. Conclusion

In this Paper a Microstrip Low pass Filter is designed. This Paper shows the design of Microstrip Low pass Filter using ANSYS HFSS with FR4 Epoxy as substrate. The Low Pass Filter is of ninth order. Hence it removes the unwanted the electromagnetic signal.

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