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A Review on Micro strip Band Pass Filters for Global Positioning System Applications

Ms. Neeta .S.Pingle
Electronics & Communication Engineering Department
Marathwada Institute of Technology
Aurangabad , India
neetapingle2010@gmail.com

Dr. Abbhilasha D.Mishra
Electronics & Communication Engineering Department
Marathwada Institute of Technology
Aurangabad , India
abbhilasha@gmail.com

Abstract**—**Global positioning system is a worldwide radio navigation system formed from a constellation of 24 satellites and their ground stations. GPS receivers are becoming miniaturized. Radio frequency (RF) filters operating in the microwave frequency range are needed for applications including wireless and satellite communications as well as military applications. Most communication system contains an RF front end which performs signal processing with RF filters. Planar or printed circuit board (PCB) based filters are popular and relatively practical to design. Band pass filters play a significant role in wireless communication systems. Transmitted and received signals have to be filtered at a certain center frequency with a specific bandwidth. This paper focuses on review of L-band BPF filter designs at center frequency 1.575 GHz developed by different researchers & in depth analysis of methods used by them.

Keywords*- RF,L-Band, Printed Circuit Board , Global Positioning System, Band Pass Filter*

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I. INTRODUCTION

There is an increasing demand for newer microwave and millimeter wave systems to meet the emerging telecommunication challenges with respect to size, performance and cost. The advances of telecommunication technology arising hand in hand with market demands and governmental regulations push the invention and development of new applications in wireless communications. Microwave communication systems are expanding rapidly to higher frequency such as L-band since they can provide many advantages over conventional wireless links, for example the larger bandwidth and smaller device size. Band pass filters are essential building blocks for communication system. Band pass filter is a passive component which is able to select signals inside a specific bandwidth at a certain center frequency and reject signals in another frequency region. They can reduce the harmonic and spurious emissions for transmitters and may improve the rejection of interferences for receivers. Microstrip line is a good candidate for filter design due to its advantages of low cost, compact size, light weight, planar structure and easy integration with other components on a single board. To ease the integration between bandpass filters and other active devices many previous works on planar filter design were reported . In this work we have selected bandpass filter for GPS application with parallel coupled microstrip line as to the which design filter for wireless local area network 5.75GHz and which used the composite resonators and stepped impedance resonators for filter realization. Our goal is to achieve high accuracy in obtaining the required designed parameters (center frequency, return loss and insertion loss). The design and simulation can be performed using 3D full wave method of moment based electromagnetic simulator IE3D . The response of the filter can be verified using a program code in MATLAB.

II . GLOBAL POSITIONING SYSTEM

Global Positioning System (GPS) is a satellite-based radio-positioning and time-transfer system designed, financed, deployed, and operated by the U.S. Department of Defense.

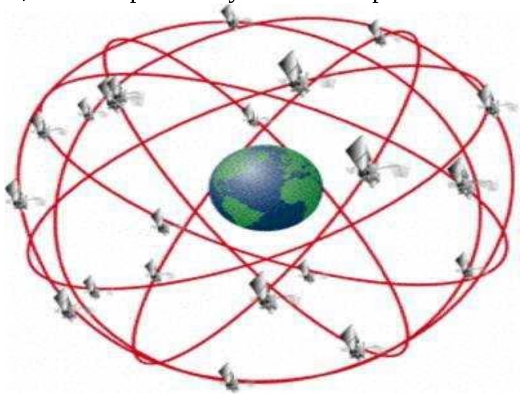

Fig 1: GPS constellations Diagram

GPS pinpoints the location of a device on planet Earth , raises some interesting ideas and applications. Primarily, GPS (Global Positioning System) was intended to be released to the consumer market as a way to aid navigation. The principle behind GPS is that receivers are able to use the technique of "trilateration" to calculate their coordinates on Earth by measuring the time taken for signals from various satellites to reach them.

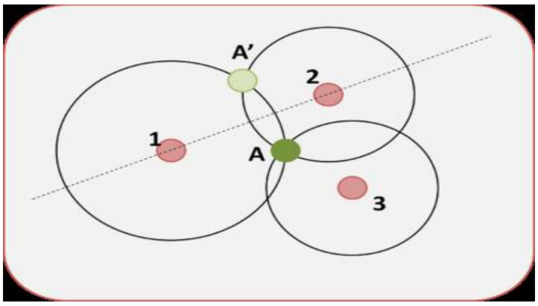

Fig 2: Trialteration method

The GPS software will account for any irregularities in the signal strength and clock differences between itself and the GPS satellite network by using signals from four separate satellites to improve accuracy. Usually the coordinates are then used to locate the GPS device on a map, which is either displayed to the user or used as a basis for calculating routes, navigation, or as input into mapping programs. For example, specific coordinates can be stored as way points allowing the user to retrace their steps by calculating the direction and distance to each waypoint that they have stored. GPS is a one-way ranging system i.e. signals are only transmitted by the satellite. Signal travel time between the satellite and the receiver is observed and the range distance is calculated through the knowledge of signal propagation velocity. One way ranging means that a clock reading at the transmitted antenna is compared with a clock reading at the receiver antenna. But since the two clocks are not strictly synchronized, the observed signal travel time is biased with systematic synchronization error. Biased ranges are known as pseudoranges. Simultaneous observations of four pseudoranges are necessary to determine X, Y, Z coordinates of user antenna and clock bias. Real time positioning through GPS signals possible by modulating carrier frequency with Pseudorandom Noise (PRN) codes. These are sequence of binary values (zeros and ones or +1 and -1) having random character but identifiable distinctly. Thus pseudoranges are derived from travel time of an identified PRN signal code. Two different codes viz. P-code and C/A code are in use. P means precision or protected and C/A means clear/acquisition or coarse acquisition. P- code has a frequency of 10.23 MHz. This refers to a sequence of 10.23 million binary digits or chips per second. This frequency is also referred to as the chipping rate of P-code. Wavelength corresponding to one chip is 29.30m. The P-code sequence is extremely long and repeats only after 266 days. Portions of seven days each are assigned to the various satellites. As a consequence, all satellite can transmit on the same frequency and can be identified by their unique one-week segment. This technique is also called as Code Division Multiple Access (CDMA). P-code is the primary code for navigation and is available on carrier frequencies L1 and L2. The C/A code has a length of only one millisecond; its chipping rate is 1.023 MHz with corresponding wavelength of 300 meters. C/A code is only transmitted on L1 carrier. GPS receiver normally has a copy of the code sequence for determining the signal propagation time. This code sequence is phase-shifted in time step-by-step and correlated with the received code signal until maximum correlation is achieved. The necessary phase-shift in the two sequences of codes is a measure of the signal travel time between the satellite and the receiver antennas. This technique can be explained as code phase observation. For precise geodetic applications, the pseudo ranges should be derived from phase measurements on the carrier signals because of much higher resolution. Problems of ambiguity determination are vital for such observations. The third type of signal transmitted from a GPS satellite is the broadcast message sent at a rather slow rate of 50 bits per second (50 bps) and repeated every 30 seconds. Chip sequence of P-code and C/A code are separately combined with the stream of message bit by binary addition I e the same value for code and message chip gives 0 and different values result in 1.The main features of all three signal types used in GPS observation viz carrier, code and data signals are given in Table 1.

Table 1:GPS Satellite Signals

Atomic Clock	(G, Rb) fundamental frequency 10.23. MHz
L1 Carrier Signal	154 X 10.23 MHz
L1 Frequency	1575.42 MHz
L1 Wave length	19.05 Cm
L2 Carrier Signal	120 X 10.23 MHz
L2 Frequency	1227.60 MHz
L2 Wave Length	24.45 Cm
P-Code Frequency (Chipping Rate)	10.23 MHz (Mbps)
P-Code Wavelength	29.31 M
P-Code Period	267 days : 7 Days/Satellite
C/A-Code Frequency (Chipping Rate)	1.023 MHz (Mbps)
C/A-Code Wavelength	293.1 M
C/A-Code Cycle Length	1 Milisecond
Data Signal Frequency	50 bps
Data Signal Cycle Length	30 Seconds

III . MICRO STRIP FILTERS :

Microstrip filters play various roles in wireless or mobile communication systems. Microwave and RF filters are widely used in this system in order to discriminate between wanted and unwanted signal frequencies. Figure 5 shows the dielectric layer of microstrip substrate. Microstrip transmission lines consist of a conductive strip of width (W)and thickness (t) and a wider ground plane, separated by a dielectric layer ("substrate") of thickness (h). The major advantage of microstrip over stripline is that all active components can be mounted on top of the board. The disadvantages are that when high isolation is required such as in a filter or switch, some external shielding may have to be considered. Given the chance, microstrip circuits can radiate, causing unintended circuit response. A minor issue with microstrip is that it is dispersive, meaning that signals of different frequencies travel at slightly different speeds. Variants of microstrip include embedded microstrip and coated microstrip, both of which add some dielectric above the microstrip conductor.

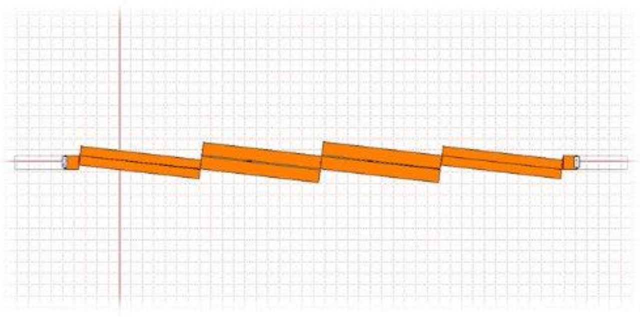

Fig 3:Structure of a three-pole micro strip parallel-coupled band-pass filter

Due the absence of a top ground plate and the dielectric substrate above strip,the electric field lines remain partially in air and partially in the lower dielectricsubstrate. Due to presence of discontinuity and open structure, the TransverseElectroMagnetic (TEM) mode is not pure propagate along the microstrip structure.This is what they called quasi-TEM .Low frequencies are defined to be below @ 200 mhz. So lumped element sizes (r, l, c) become comparable to wavelength also radiation from elements causes undesirable effectssuch as increased losses, wire connections between elements become part of circuit (parasetics) & sources & measurement techniques are unsuitable at higher frequency.Microwave Fiters can be clasified by 1) Type: (LP HP,BP, BS) , 2) Fractional BW. 3) Transimission Medium for eg:

1) lumped & quasi lumped elements

2) coaxial transmission lines

3) micro strip lines

4) suspended substrate lines

5) strip lines

6) rectangular or cylindrical waveguides

7) high dielectric constant filled (or partially loaded) coaxial lines or waveguides

4. DESIGN METHOD:

Design specifications:

• Input and output are to be matched to 50 ohm impedance
• Cut off frequency: In the L Band (1.57 GHz)
• Equi-ripple of 0.5 dB;
•Rejection of at least 40dB at approximately twice the cut off frequency.

1) The order of the filter is to be decided ,
2) The inductances and capacitances are to be replaced by open and short circuit seriesand shunt stubs.
3)To match the source and load sides, and to make the filter realizable, unitelements are to be introduced with the intent to apply the first and second Kuroda's identitiesto convert all series stubs to shunt stubs.

A simulation study was performed to verify the validity of the above dimensions in millimeter wave regime using either CAD FEKO, HFSS, IE3D softwares. Analysis of filter can be done with MATLAB.

5 CONCLUSION

The filters are one of the primary and essential parts of the microwave system and any communication system. Any communication system cannot be designed without filters. Global positioning system is a worldwide radio navigation system formed from a constellation of 24 satellites and their ground stations. GPS receivers are becoming miniaturized and are becoming very economical and this makes the technology accessible to virtually everyone. GPS receiver needs compact,low cost high performance bandpass filter. Results for a bandpass filter operating at 1.57 GHz have been collected . The obtained results have shown good performances in terms of low insertion loss and high selectivity in the pass-band.

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