3 Bit Analog RF Phase Shifter Using Micro-strip

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Abstract: In radio communication phase shifter is used for many applications. There is a requirement to design phase shifter which will have high performance with very less cost and very less power consumption. In this work we are proposing Micro-strip based phase shifter design having three control voltage level to get 8 different phase shifts such as 22.5°, 45°, 90°....covering wide bandwidth from 2GHz to 3GHz. The proposed phase shifter will be based on switched line (high pass/low pass) topology. This phase shifter can perform phase shifting function on RF waves with low power. This phase shifter circuit will be built with three 1 bit phase shifter sections and all of this section can be controlled individually by tuning three voltage levels. The major application of micro-strip based phase shifter will be in "SUB-HARMONICALLY PUMPED MIXER" and Modulator block in a wireless Transceiver architecture.

Keywords: Phase shifter, switch-line topology, micro-strip, ADS software, Sub-harmonically pumped mixer.

I. INTRODUCTION:

In field of communication, phase shifter is basically used for getting phase shifted waveforms. Analog RF phase shifter can be constructed using lumped component such as inductor, capacitor etc. But desired high value of inductor and capacitor are not easily available in market, circuit become bulky using lump component. Switch line phase shifter is one of the most important types of phase shifter. This phase shifter circuit will be built with three 1 bit phase shifter section to get phase shifted waveform such as 22.5°, 45°, 90° ......And all three sections can be controlled individually by tuning three voltage levels. “SUB HARMONICALLY PUMPED MIXER”is the one application of phase shifter in this we can use phase shifter before local oscillator so that the phase shifted waveforms will be given to mixer through local oscillator and another input to mixer is RF input. This helps for elimination of noise at the output of mixer. Switch line phase shifter is one of the phase shifter based on diodes as a switch and their phase shift corresponds to the length difference between two switched transmission lines. In switched line topology instead of diode switched IC will be helpful for reducing losses of diode and bulkiness.

II. PROBLEM AND OBJECTIVE:

In communication system the basic requirement is elimination of noise. This can be done using filter at the output of mixer. But the circuit becomes bulky. Instead of this we can use phase shifter before local oscillator so that the phase shifted waveforms will be given to mixer through local oscillator and another input to mixer is RF input. This helps for elimination of noise at the output of mixer.

Analog RF phase shifter can be constructed using lumped component such as inductor, capacitor etc. But desired high value of inductor and capacitor are not easily available in market, circuit become bulky. Alternate solution is to design phase shifter using micro-strip which can be of low cost, less bulky, and consumes low power.

III. DESIGN AND IMPLEMENTATION:

Fig 1: Design of 22.5° phase shifter using lumped components (ADS software)

Fig 2: S-Parameter Results graph (22.5°)
The following procedure is used for the design of 22.5°, 45°, 90°, 180°……Switched line phase shifter using microstrip.

1) Initially started with the design of suitable dimension based on availability from the market, so widely available substrate FR-4 was chosen with 0.035 mm of thickness.

2) Selecting W and H value such that it gives impedance of 50 Ω. (W/H ratio should be greater than 1)

3) Based on the basic schematic of the switch-line phase shifter a design consisting of measured width for microstrip line and line difference for phase shift was carried out.

4) The above-mentioned design will be completed using SPDT switch IC instead of diodes, so that loss can be reduced.

5) Further implementation will be done on ADS software.

The required specifications of phase shifter are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2.3 to 2.6</td>
<td>GHz</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>-3</td>
<td>dB</td>
</tr>
<tr>
<td>Phase Shift</td>
<td>22.5°, 45°, 90°, 180°...</td>
<td>Degree</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>&lt; -10 dB</td>
<td></td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>&lt; -10 dB</td>
<td></td>
</tr>
<tr>
<td>No of Input Bits</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Micro-strip</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Specification of phase shifter using micro-strip
Fig 8: S-Parameter Results graph (180°)

V. CONCLUSION:

In this project we will build the RF phase shifter which gives us 22.5°, 45°, 90°, 180°..... phase shift using micro strip technology. In RF analog phase shifter we will control the switches by 3 voltage levels (3 bits) and successfully modeled the 22.5°, 45°, 90°, 180°..... of phase shift using micro-strip and designed the layout of SPDT switch IC on ADS software.

REFERENCES:


