Abstract

A CMOS variable gain amplifier (VGA) has been implemented for the ultra-wideband (UWB) system using multi-orthogonal frequency division multiplexing (OFDM) modulation technique.

The VGA is composed of three cascade stages to increase the gain range. The first two stages are variable gain stages and the third stage has a fixed gain performance.

Since voltage gain and bandwidth are tradeoffs, compromises need to be made to meet certain specifications based on the feasibility of the design.

To expand the bandwidth, some techniques for the bandwidth enhancement have been adopted.

In the design, voltage generator will be incorporated, which voltage gains can change 0-V, linearly with the control voltage.

Common mode feedback circuit has been introduced in each stage of the VGA to stabilize the output for common mode voltage.

Common mode feedback circuit has been included in each stage of the VGA to minimize the input referred DC offset.

Design Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>1.8 ± 1%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>&lt;380mW</td>
</tr>
<tr>
<td>Gain control range</td>
<td>&gt;40dB</td>
</tr>
<tr>
<td>S11 bandwidth</td>
<td>&gt;260MHz</td>
</tr>
<tr>
<td>Differential Output</td>
<td>1V p-p</td>
</tr>
<tr>
<td>Output load</td>
<td>50Ω</td>
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</tbody>
</table>

Implementation

The exponential voltage generator designed in the project can verify the current and voltage exponential relationship generated by the diode-connected MOS working in the subthreshold region.

As shown in Fig.6, the voltage gain has a dB-linear performance with respect to the control voltage in the range from -10dB to 0dB.

The variable gain stage can obtain a varied gain by adjusting the source degeneration, which is the MOS working in the linear region. The gate voltage of the source degeneration is generated by the exponential voltage generator.

Because of the active load used in the design, common mode feedback circuit is introduced in each stage to fix the common mode voltage level of the output signal.

As shown in Fig.6, the voltage gain can vary dB-linearly with respect to the control voltage from -10dB to 40dB.

As shown in Fig.7, the bandwidth of the proposed VGA is more than 300MHz.

When the voltage gain is 0dB, and the frequency of the input signal is 100MHz and the output signal is 0.9V P-P, the total harmonic distortion (THD) is equal to -44.6dB.

Conclusions

A CMOS variable gain amplifier for UWB system is developed in this project with TSMC 0.18um technology. The VGA has a wide gain range of around 50dB, wide bandwidth of more than 300MHz and good linearity. The output swing is around 1V and the power consumption is 9.1mW.