**Introduction**

In this final year project, microstrip antennas for a 2.4GHz ZigBee™ transceiver were design and built.

This project was supported by Sengital Ltd. We had co-operated with the company and implemented our antenna designs into their ZigBee™ module to improve its performance.

To further increase the challenge of this project, a power amplifier and low noise amplifier modules were built and added to the transceiver to increase its operation range.

**Aim and Objectives**

Improve the performance of the transceiver through
- Increase its transmitting range
- Decrease the size of the transceiver module.

**System Block Diagram**

![System Block Diagram](image)

**Fig 1** 2.4GHz RF transceiver ZigBee module (from http://www.sengital.com/)

**Fig 2** Photo of receiving side of ZigBee transceiver with Low noise amplifier added

**Fig 3** Photo of transmitting side of ZigBee transceiver with Balun, Power amplifier module and inverted F-antenna added
Schematics and layouts of modules

Monopole Inverted F antenna

Dipole Bent antenna

Power Amplifier Module

Low Noise Amplifier Module

Fig 4 photo of inverted-F antenna

Fig 5 photo of bent dipole antenna

Fig 6 photo of PA module

Fig 7 photo of LNA module
Experiments and Results

The following experiments were implemented and the results were shown below:

(a) Comparison of Sengital’s antenna, Inverted F antenna, Dipole antenna (Distance 1.5m)
(b) ZigBee transceiver transmitting signal through F-antenna (Distance 1m)
(c) Amplify the signal by a PA and transmits through F-antenna
(d) Transmitting signal through F-antenna and amplify the received signal through LNA in the receiving end
(e) Amplify the signal by a PA and transmits through F-antenna. Amplify the received signal through LNA in the receiving end.

By using 3 different designs of antennas for transmitting signal, the power recorded form the spectrum analyzer was summarized in the following table:

<table>
<thead>
<tr>
<th>Experiment (a)</th>
<th>Power intensity received at 2.410GHz</th>
<th>Power intensity received at 2.445GHz</th>
<th>Power intensity received at 2.810GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sengital (Original design)</td>
<td>-48.33dBm</td>
<td>-47.64dBm</td>
<td>-46.74dBm</td>
</tr>
<tr>
<td>Monopole inverted F</td>
<td>-45.68dBm</td>
<td>-45.68dBm</td>
<td>-46.67dBm</td>
</tr>
<tr>
<td>Dipole</td>
<td>-46.12dBm</td>
<td>-45.68dBm</td>
<td>-43.61dBm</td>
</tr>
</tbody>
</table>

The power recorded from the Spectrum Analyzer was summarized in the following table:

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Average Power received (dBm)</th>
<th>Average Power gain (dB)</th>
<th>Current consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>-38</td>
<td>-</td>
<td>~30mA</td>
</tr>
<tr>
<td>(c)</td>
<td>-27</td>
<td>11</td>
<td>~45mA</td>
</tr>
<tr>
<td>(d)</td>
<td>-32</td>
<td>6</td>
<td>~36mA</td>
</tr>
<tr>
<td>(e)</td>
<td>-23</td>
<td>15</td>
<td>~52mA</td>
</tr>
</tbody>
</table>

Conclusion

By using our antenna designs and implementing PA and LNA module. The ZigBee transceiver module could extend the radiation range by 41%