GPS Patch Antenna Considerations
Contents

- Antenna Element
- Impedance and Resonant Frequency
- Axial Ratio
- Voltage Standing Wave Ratio (VSWR)
- Bandwidth
- Result of Measurement
The antenna’s size and shape

- compact size using ceramic material
- RHCP (Right Hand Circular Polarization) patch

Diagram:

- Offset fed rectangular patch
- Slotted square patch
- Truncated corner square patch
AMOTECH - GPS Patch Antenna

- compact size: 25mm × 25mm × 4mm
- excellent temperature stability
- (silver plated) truncated corner square patch
Impedance and Resonant Frequency

An antenna’s impedance depends on many factors:

- how it is constructed,
- how it is fed,
- and to some degree, the surrounding environment.

A microstrip patch antenna placed in a plastic enclosure (radome), for example, can have its resonant frequency shifted downward by several MHz, depending on

- the thickness of the radome
- its dielectric constant
- and the distance between the antenna face and inner radome.
Impedance and Resonant Frequency

Radome effect on resonant frequency

- Final Assembly
- Assembly without radome
- Patch on 70 by 70 ground

The final assembly obtains optimized operation over 1575.42MHz ± 3MHz
Axial Ratio

General description

- To be maximally sensitive to GPS signals, the ideal GPS antenna should be perfectly RHCP.
- The more elliptically polarized it is, the lower its RHCP sensitivity.
- The degree of ellipticity is given by the antenna’s axial ratio.
- Good GPS antennas have an axial ratio in the zenith direction of 3dB or better.
- A measurement of the VSWR alone does not guarantee the antenna’s axial ratio performance.
Axial Ratio

Measure the Axial Ratio

- The GPS Patch antenna transmits at the desired frequency.
- Rotates the linear polarization probe
- \( AR = A - B \), in dB

Measuring system in AMOTECH

![Diagram of measurement setup]

- Signal Generator
- Spectrum Analyzer
- PC
- Signal Generator
- <Anechoic Chamber>
- rotate test probe
- 7.26 m
- 3 m
An important consideration is the antenna-receiver connection. This is achieved with a transmission line, usually a coaxial cable.

To maximize signal transfer from the antenna to the receiver, we must minimize power loss.

Power may be lost if the coupling between the antenna and the cable is imperfect and also within the cable itself.

To prevent power loss at the interface between the cable and the antenna, the impedance of the cable and the antenna must be the same.

The formula for relating mismatch loss to VSWR is:

\[
\text{Mismatch Loss (dB)} = 10 \log \left( 1 - \frac{(VSWR-1)^2}{VSWR+1} \right)
\]
Bandwidth

- Operating bandwidth is defined as frequency range satisfied following:
  - VSWR (< 2.0) or Return loss (< 10 dB)
  - Axial ratio (< 3.0 dB)

- GPS patch antenna designed by AMOTECH satisfies all criteria over the operating frequency range of 1575.42 MHz ± 3 MHz.
Result of Measurement

GPS Antenna installed on Infinite Ground

Geometry of final assembly

Axial Ratio

![Diagram of antenna assembly](image)

<table>
<thead>
<tr>
<th>Frequency [MHz]</th>
<th>Axial Ratio [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1565</td>
<td>12</td>
</tr>
<tr>
<td>1570</td>
<td>10</td>
</tr>
<tr>
<td>1575</td>
<td>8</td>
</tr>
<tr>
<td>1580</td>
<td>6</td>
</tr>
<tr>
<td>1585</td>
<td>4</td>
</tr>
</tbody>
</table>

AMOTECH
Result of Measurement

GPS Antenna installed on Infinite Ground

Return Loss

Smith chart
Result of Measurement

GPS Antenna installed on 70mm × 70mm Ground

Return Loss

Smith chart
Result of Measurement

GPS Antenna installed on 50mm × 50mm Ground

Return Loss

Smith chart
Result of Measurement

GPS Antenna without Ground

Return Loss

Smith chart
Result of Measurement

Geometry of assembly without radome

Axial Ratio

GPS Antenna without Radome on Infinite Ground

Infinite Ground

Axial Ratio vs Frequency [MHz]
Result of Measurement

GPS Antenna without Radome on Infinite Ground

Return Loss

Smith chart
Result of Measurement

GPS Antenna without double sided adhesive tape

Return Loss

Smith Chart
Result of Measurement

GPS Patch Antenna on 70 by 70 AMOTECH Test Jig

Geometry of patch antenna

Axial Ratio

![Graph showing frequency vs. axial ratio for GPS Patch Antenna]
Result of Measurement

GPS Patch Antenna on 70 by 70 AMOTECH Test Jig

Return Loss

Smith Chart