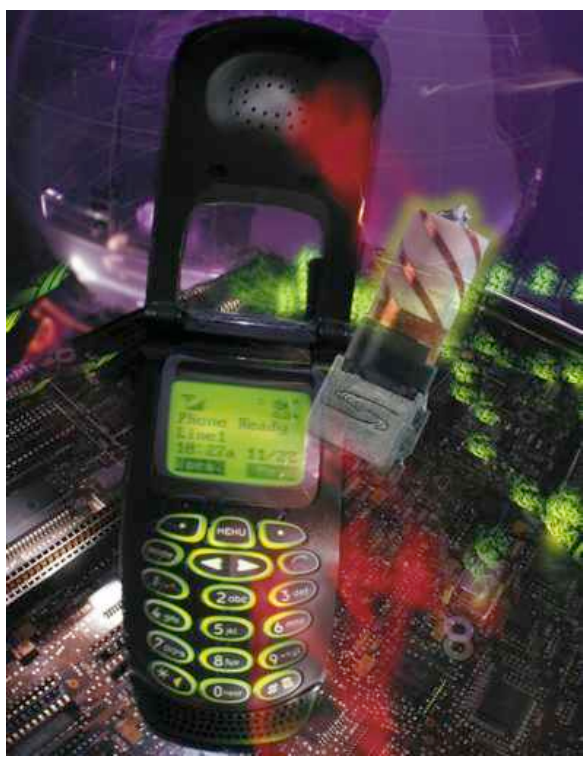
APPLICATION NOTE

GeoHelix GPS Antennas in Mobile Phone Applications



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1.0 Introduction

1.1 Scope

The purpose of this application note is to demonstrate that excellent GPS performance is provided when integrating a Sarantel GeoHelix GPS antenna into a mobile phone.

Comparison measurements were made between the GeoHelix SMP passive surface mount antenna embedded into a commercially available UMTS mobile phone and the internal GPS antenna, a PIFA, supplied with the phone. Testing in intended-use positions as well as free space yields a better proxy for how the antenna will perform in real world situations, therefore measurements were carried out using a dielectrically loaded phantom hand.

1.2 About the GeoHelix GPS Antenna

Structurally, the GeoHelix GPS antenna is a quadrifilar helix plated on a cylinder of high-dielectric ceramic. The integration of a balun on this structure transforms a single-ended, coaxial feed into a balanced load. The dielectric value of the ceramic material shrinks the size of the antenna into a volume much smaller than that of a conventional air-dielectric quadrifilar antenna, and because the antenna is balanced, it does not require a ground plane.

The structure, materials, and electromagnetic properties of the GeoHelix antenna create a very stable frequency and gain response regardless of the use position of the device on which the antenna is mounted. The GeoHelix has a near field that is constrained very tightly around the antenna. Therefore, high dielectric materials like the hand, head, or body of the user do not interact with the near field. The integrated balun isolates the resonating section of the antenna very strongly from the ground of the radio, rejecting common mode noise that exists on the radio ground and preventing that noise from being conducted into the receiver circuitry. Taken in concert, the properties of the GeoHelix antenna allow it to function independently of the device on which it is mounted.

1.3 Test Procedure

Tests were performed under laboratory conditions in an anechoic test chamber and under practical conditions in rural and urban environments.

The following measurements were performed:

- Pattern measurement of the mobile phone's original antenna with and without phantom hand loading in azimuth and elevation planes.
- Same measurements with the GeoHelix SMP antenna mounted on the phone.
- Time to position fix using the phone as designed in stationary and drive tests.
- Time to position fix using the phone modified by adding the GeoHelix antenna.

2.0 Pattern Measurements

Pattern measurements were carried out in an anechoic chamber with antennas measured in both azimuth and elevation planes. Before making any measurements, the antennas were isolated from the rest of the phone circuitry, rendering the antennas independent of any loading from the handset.

2.1 Chamber Setup

The anechoic chamber is organised horizontally, and uses a right-hand circularly polarised source antenna to represent the GPS satellite signal. Figure 1 shows the chamber organised for an azimuth plane measurement. In this plane, the ideal pattern is a circle. Figure 2 shows the chamber organised for an elevation plane measurement. In this plane, the ideal pattern is a cardioid.

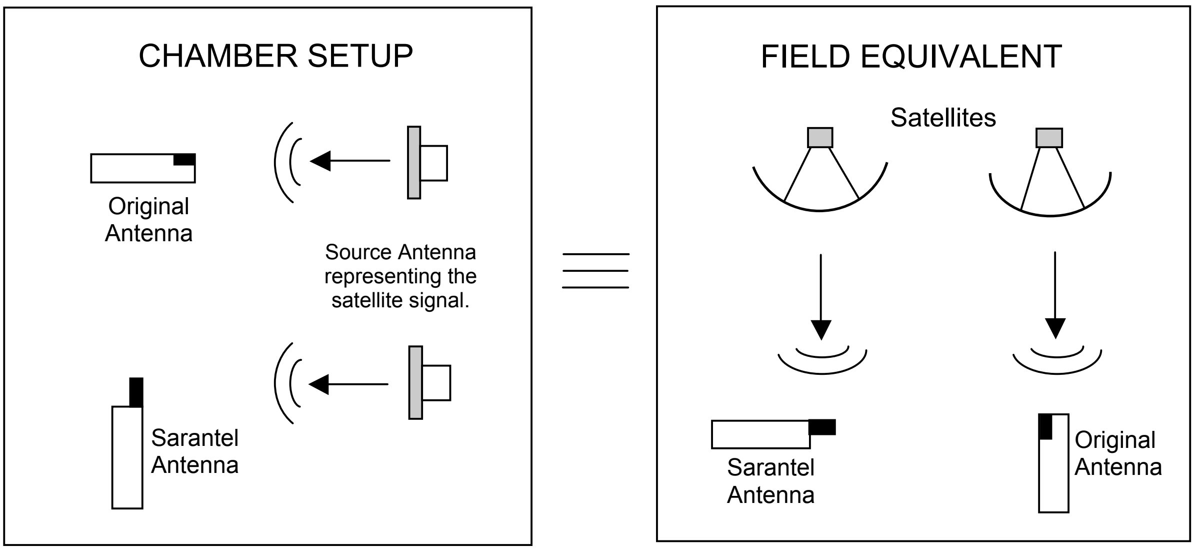


Figure 1: Azimuth plane measurement setup

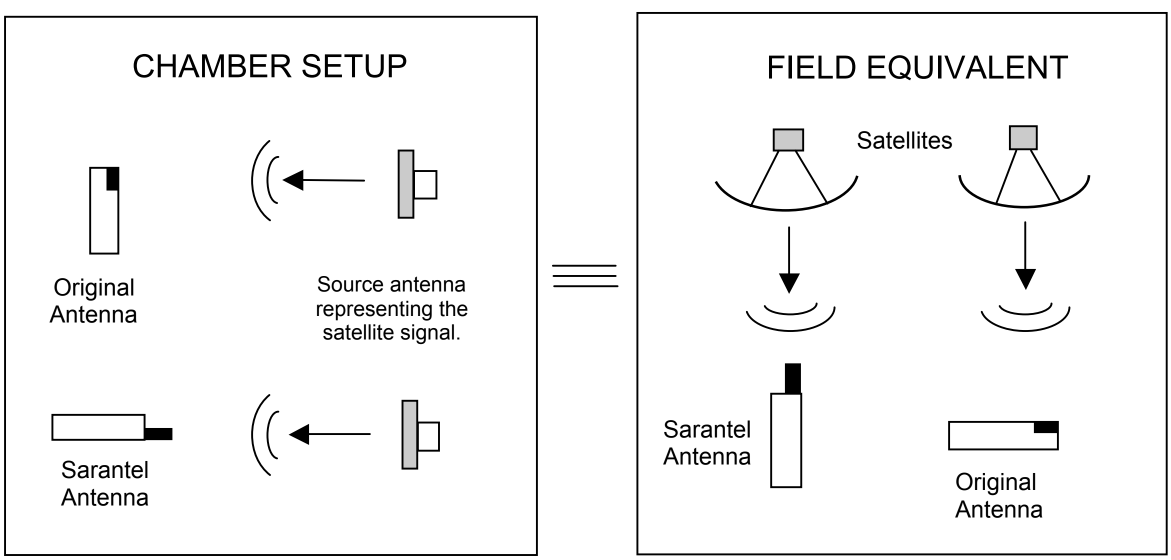
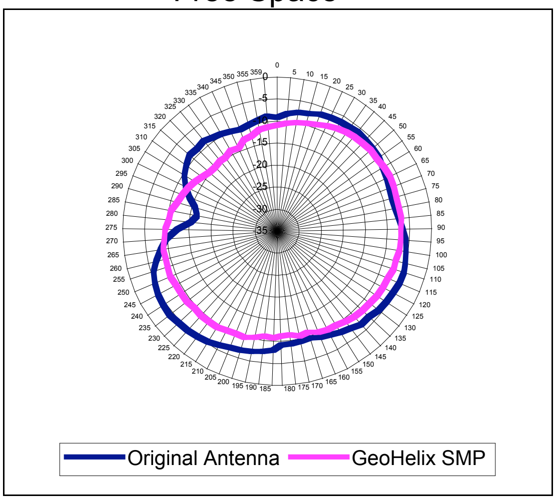


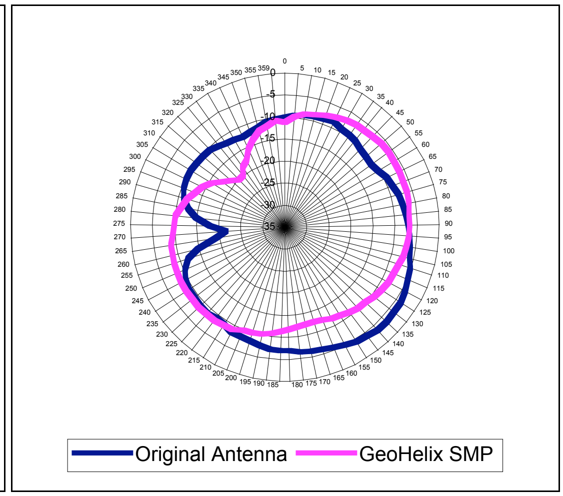
Figure 2: Elevation plane measurement setup

2.2 Azimuth Plane Measurements

Free Space



Phantom Hand Loaded



Free Space Azimuth Pattern	Original Antenna	GeoHelix SMP	Δ	Advantage
Max Gain (dBic)	-4.2	-6.7	2.5	Original
Min Gain (dBic)	-16.6	-14.9	1.7	GeoHelix
Max/Min Δ (dB)	12.3	8.2	4.1	GeoHelix
Average Gain (dBic)	-7.9	-9.8	1.9	Original

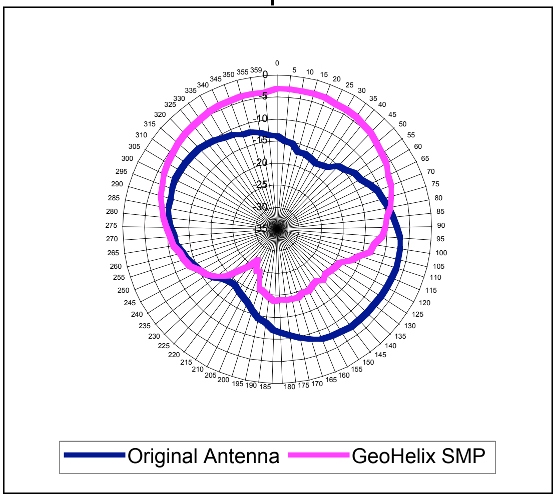
Phantom Hand Loaded Azimuth	Original Antenna	GeoHelix SMP	Δ	Advantage
Max Gain (dBic)	-3.5	-6.1	2.5	Original
Min Gain (dBic)	-21.7	-20.0	1.6	GeoHelix
Max/Min Δ (dB)	18.1	14.0	4.2	GeoHelix
Average Gain	-9.2	-10.3	1.1	Original

Comments

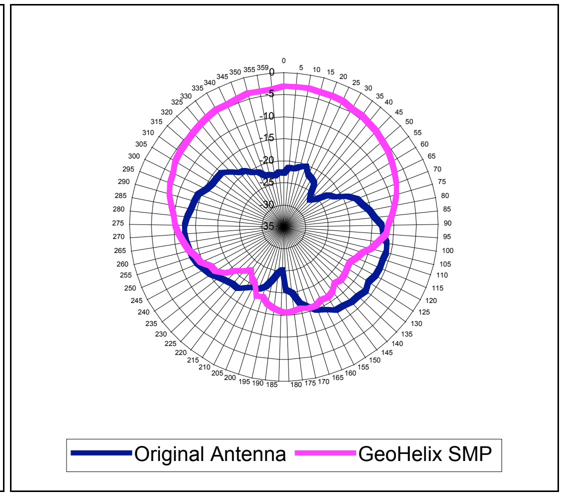
Both antennas demonstrate some pattern irregularities in the azimuth plane from the desired circular pattern. The original antenna holds a slight advantage in maximum and average gain, while the GeoHelix SMP holds a greater advantage in pattern uniformity (Max/Min Δ) in both the free space and phantom loaded measurements.

2.3 Elevation Plane Measurements

Free Space



Phantom Hand Loaded



Free Space Elevation Measurements	Original	GeoHelix	Δ	Advantage
Peak Gain (dBic)	-13.9	-3.2	10.7	GeoHelix
Front/Back Ratio (dB)	2.3	15.8	13.5	GeoHelix
Average Upper Hemisphere Gain (dBic)	-12.3	-5.8	6.4	GeoHelix

Phantom Loaded Elevation Measurements	Original	GeoHelix	Δ	Advantage
Peak Gain (dBic)	-22.9	-3.2	19.7	GeoHelix
Front/Back Ratio (dB)	2.1	12.4	10.3	GeoHelix
Average Upper Hemisphere Gain (dBic)	-19.1	-6.1	13.0	GeoHelix

Comments

The antennas are clearly differentiated in these measurements, with the GeoHelix SMP antenna showing a distinct advantage. The GeoHelix demonstrates a cardioid pattern characteristic of well-formed right hand circularly polarised antennas. The original antenna measures poorly in both tests, but the phantom hand has a much more significant impact on the original antenna in this plane than it did in the azimuth plane. In contrast, the phantom hand has an insignificant impact on the GeoHelix antenna in either measurement plane.

3.0 MEASURING RESPONSE TIME

Time to position fix is a critical determinant of the efficacy of the GPS receiver in the mobile phone – long response times may have an impact on safety. In these tests, initial response time was measured from the time the phone was switched ON (cold start) until a valid position fix was obtained and approximately every two seconds thereafter. In total, 10 measurements were taken to determine average response. Tests were carried out in the field in three conditions: stationary hand-held with an open sky, driving in a mixed rural/urban environment with the antenna on the dashboard of the car, and walking in an urban environment.

Phone Position	GPS Lock Attempt	Original Antenna (secs)	GeoHelix SMP (secs)
Handheld	1	44	24
	2	28	5
	3	35	5
	4	26	5
	5	21	7
	6	24	5
	7	25	5
	8	28	8
	9	27	8
	10	25	11
Average Time to Position Fix		**24 secs**	**8 secs**

Phone Position	GPS Lock Attempt	Original Antenna (secs)	GeoHelix SMP (secs)
In a car (on the Dashboard)	1	56	33
	2	39	7
	3	41	7
	4	39	9
	5	35	9
	6	43	12
	7	35	8
	8	39	9
	9	37	13
	10	34	10
Average Time to Position Fix		**40 secs**	**12 secs**

Phone Position	GPS Lock Attempt	Original Antenna (secs)	GeoHelix SMP (secs)
Urban Environment	1	61	38
	2	52	17
	3	49	18
	4	50	15
	5	39	15
	6	37	17
	7	39	17
	8	35	18
	9	37	20
	10	36	18
Average Time to Position Fix		**44 secs**	**19 secs**

Comments

The GeoHelix SMP provided a measurably superior time to position fix, from 55% to 70% faster than the original antenna in all three test conditions.

4.0 CONCLUSION

This study suggests that the far field reception pattern of the GPS antenna in a mobile phone has a significant impact on the performance of the receiver in several intended use positions. The GeoHelix SMP provided gain and pattern advantages when measured in a chamber that yielded a dramatically reduced time to fix from the receiver. It should also be noted that other characteristics of the antenna impact the performance of the receiver subsystem. Common-mode noise conducted by conventional antennas from the ground plane of the mobile phone adversely impacts the signal to noise performance of the receiver. GeoHelix GPS antennas are strongly isolated from the ground of the device and thus do not conduct common-mode noise into the receiver.

The choice of antenna does make a difference in the response time of a GPS receiver. When the device is to be used for a safety-critical function like emergency services despatch, the user must be able to depend upon a rapid time to fix. Sarantel's GeoHelix GPS antennas provide superior performance in mobile phone applications, both in controlled laboratory tests and in field demonstration.