GPS Active Antenna With GPRS Measurement Report

Summary:

This report is to account for the measurement setup and results of 40x23mm and 50 mm height GPS active antenna combined with GPRS antenna measurement.

1. The measurement accounts return loss and smith chart for the antenna.
2. The passive antenna gain was account and reported.
2. The GPS active gain with the 28 dBm GSM 1710 MHz noise signal was measured and reported.

I. Measurement Setup:

A. Reflection Coefficient Measurement:

(a) Instrument: Network Analyzer (Agilent E5071A).

(b) Setup:

(1) Calibrate the Network Analyzer by two port calibration using O.S.L .calibration kits .

(2) Place the antenna module on the specified ground plane (Fig 2.).

(3) Connect the antenna under test to the Network Analyzer.

(4) Measure the S11 (reflection coefficient), S22 (reflection coefficient), and S21 (Antenna isolation) shown in Fig. 1.

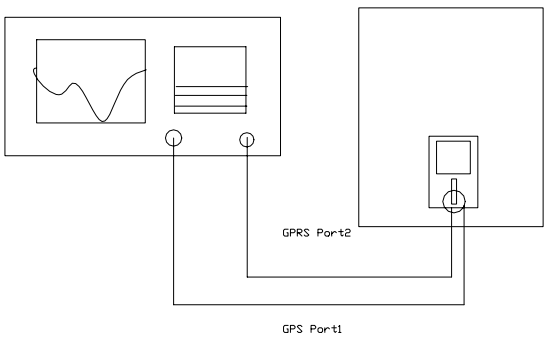


Fig 1. The reflection coefficient and antenna isolation measurement setup

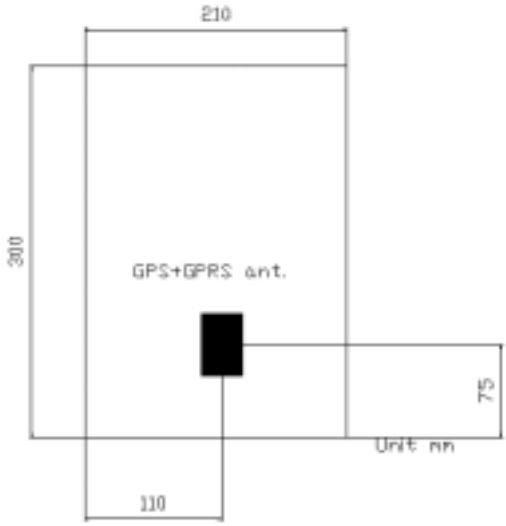


Fig 2. The setup position for the antenna on the ground planes

B. Pattern Measurement:

(a) **Instruments**: Anechoic Chamber, Network Analyzer, Standard Gain Antenna.

(b) **Chamber description**:

(1) The INPAQ's anechoic chamber is a far-field measurement system with size of 8m*4m*3.5m. The quiet zone region is 20cm x 20cm x 20cm.

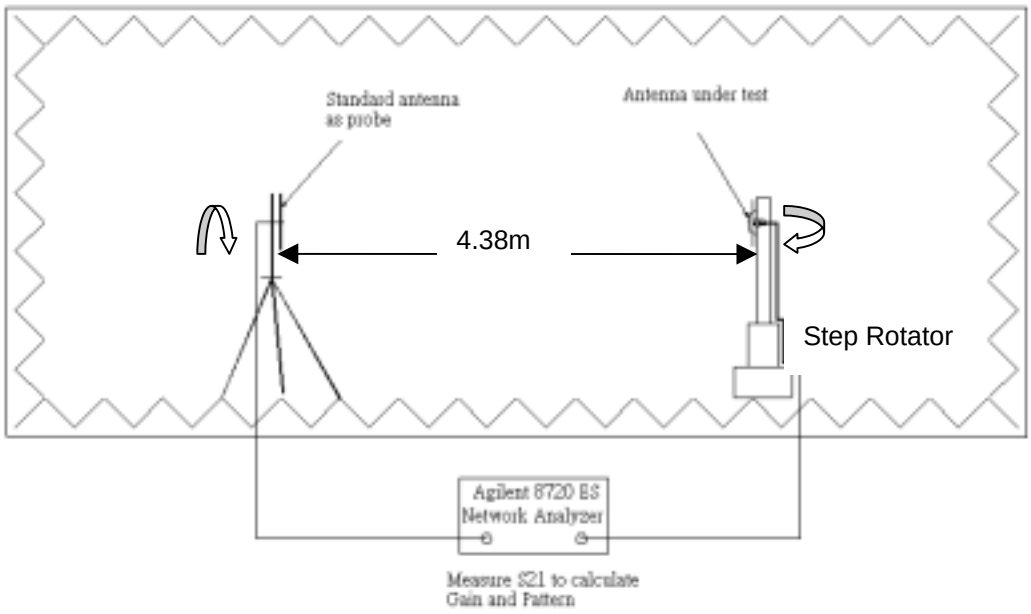


Fig. 2. The interior components of the anechoic chamber.

(2) Fig. 2 shows the interior components of Anechoic chamber and the connection to the network analyzer. The distance between standard antenna as probe and antenna under test (AUT) is 4.38m. The antenna under test is

fixed on a step rotator. We can control the rotating angle for accurate or rough measurement.

(3) The probing antenna is the TDK 900MHz~18 GHz module (9120D horn antenna).

(4) While we measure the radiation patterns by rotating AUT with 360 degrees and repeat again by replacing the AUT with the standard gain antenna under test, we compare both data and using a formula to obtain the gain of AUT. The standard gain antenna is a gain horn (BBHA 9120 LFA 700MHz~6GHZ).

$$G_{AUT} = G_{stand} + P_{AUT} - P_{stand}$$

G_{AUT} : Gain of AUT
G_{stand} : Gain of Standard Gain Antenna
P_{AUT} : Measured Power of AUT
P_{stand} : Measured Power of Standard Gain Antenna

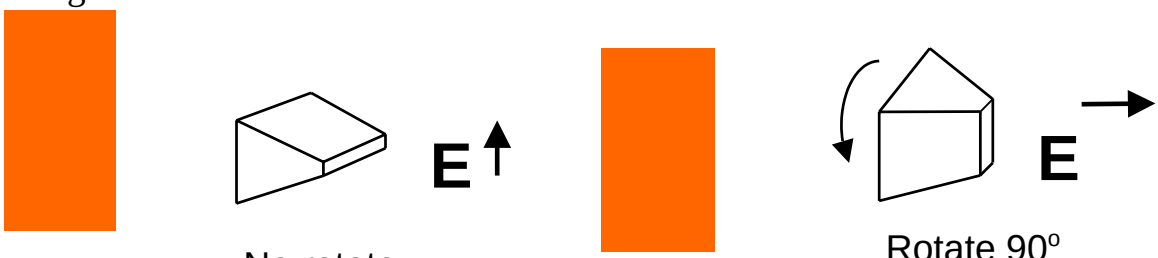
(5) We use the 50 ohm load to terminate one antenna while the another is under measurement.

(6) The planes defined in Fig. 4. is the GPRS antenna Azimuth planes in free space

(7) The planes defined in Fig. 5. is the GPS antenna Elevation 0 degree and 90 degree planes in free space.

(8) The vertical or horizontal polarization's power is measured by rotating the antenna probe to 0 degree or to 90 degree shown in Fig. 3, respectively. While we combine both vertical and horizontal power, we obtain total power.

(9) From the patterns we can verify whether the performance of the antenna is good or not.



(a) Antenna Probe at 0° as a Vertical Polarization.

(b)Antenna Probe at 90° as a Horizontal Polarization.

Fig. 3. The definition of vertical and horizontal polarization.

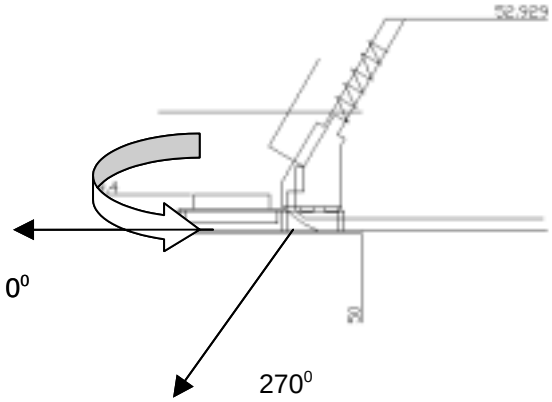


Fig 4. The Azimuth plane setup for the GPRS antenna

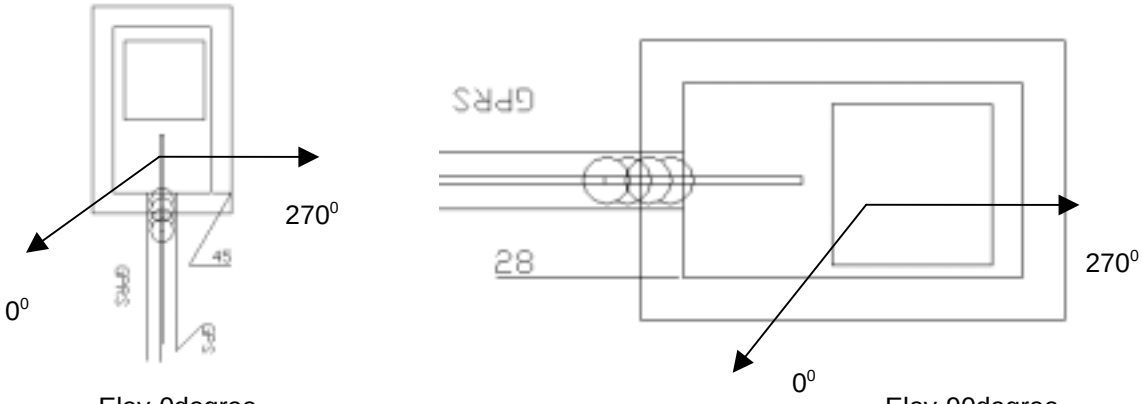


Fig 5. The Elevation 0 and 90 degrees plane setup for the GPS antenna

II. VSWR and Mutual Coupling :

The antenna performance is measured on a specified ground plane. The detail standard configuration for the application is described in Fig. 2.

The layout if the antenna module is shown in Fig. 6. Its size is 50*33*52.5 mm^3.

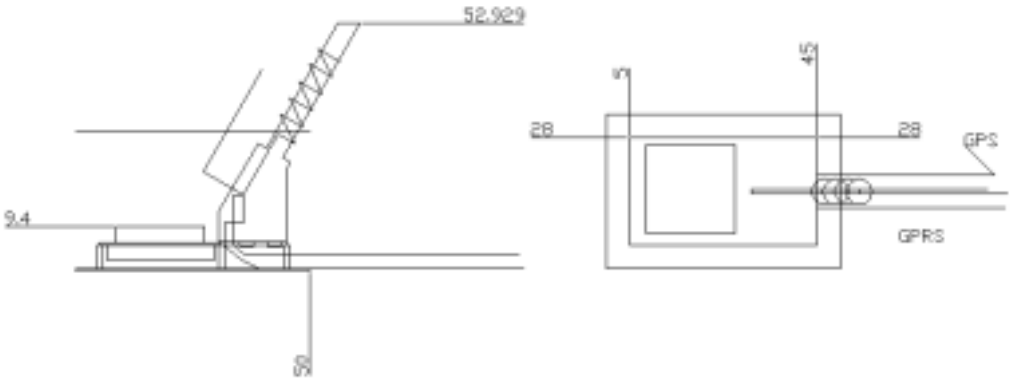
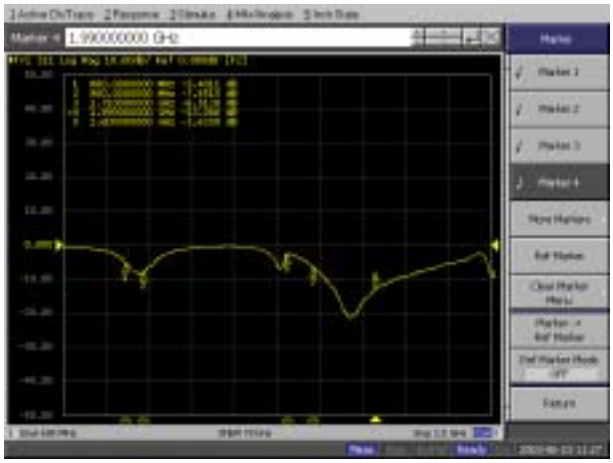
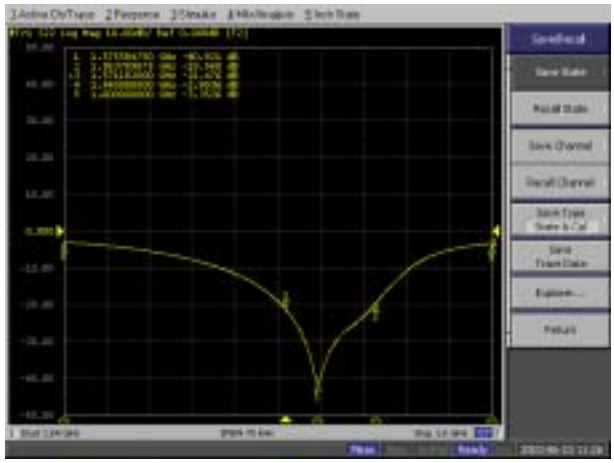


Fig 6. The outer dimension for the antenna module and the line definition.

A. Return loss



(a) GPRS return loss



(a) GPS return loss

Fig. 7. (a) The return loss GPRS antenna. (b) The return loss of GPS antenna.

B. Mutual coupling

The mutual coupling for the two antennas is as follow. We can see that the largest coupling is –16 dB in 1710MHz. We see one filter after the GPS antenna and the factor is –40 dB in 1710MHz. The total loss to the LNA input is –46 dB. If the DCS signal 28 dBm from the GPRS antenna the power become –24dBm to the LNA. This will let the LAN to reaches it's Conner conversion compression point and compress the signal receiving for the GPS.

We can see the measurement in IV to check the gain.

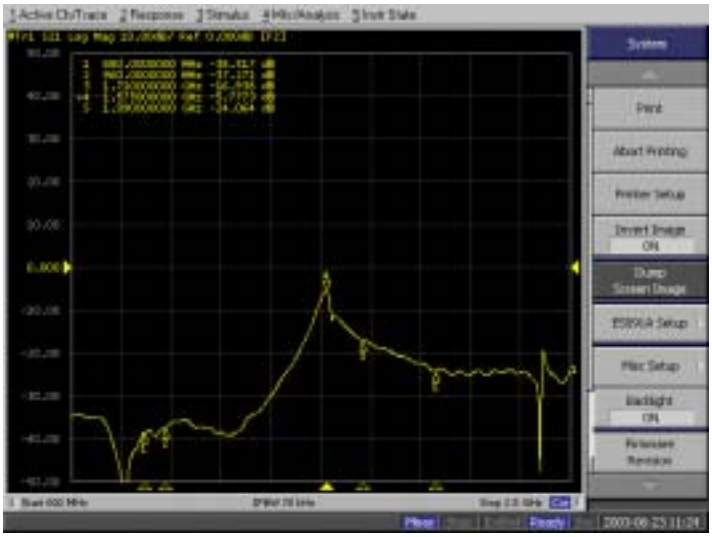


Fig. 8. The mutual coupling for the two antennas,

III. Gain and Radiation Pattern:

A: GPRS in free space:

Antenna Gain for GPRS in Azimuth.

Unit dBi	0 degree			90 degree			Total power		
MHz	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average
GSM									
880	-0.30	-3.21	-1.76	-4.95	-33.44	-9.36	0.10	-2.51	-1.07
915	-0.14	-1.95	-1.14	-6.36	-31.66	-10.65	0.17	-1.37	-0.68
960	0.06	-1.68	-1.05	-6.35	-29.21	-11.12	0.17	-1.41	-0.64
DCS & PCS									
1710	-0.64	-4.59	-1.67	-9.28	-30.01	-13.33	-0.33	-4.38	-1.39
1800	0.61	-3.43	-0.66	-6.79	-27.21	-12.46	0.90	-3.25	-0.38
1880	2.27	-2.66	0.36	-4.23	-24.18	-10.04	2.72	-1.95	0.73
1990	1.95	-4.39	-0.28	-3.47	-25.29	-9.79	2.39	-3.60	0.18

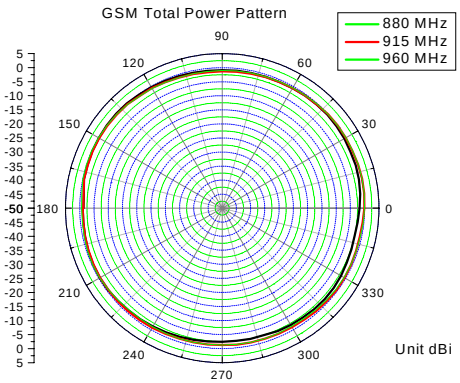
B: GPS Active Antenna Gain in free space

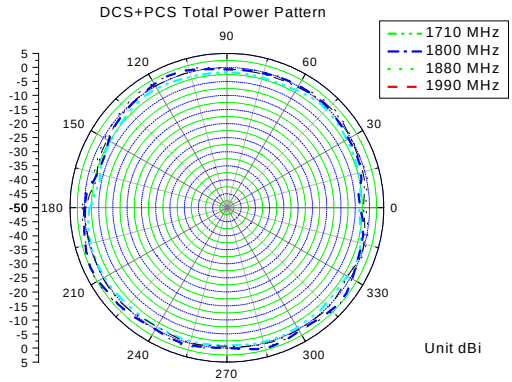
Antenna in Elevation 0 and 90 degrees

Unit dBic	0 degree			90 degree		
MHz	Max.	Min.	Average	Max.	Min.	Average
1567	28.98	-8.96	22.85	27.50	-8.18	20.57
1575	35.21	10.71	28.57	31.27	4.50	24.20
1582	37.61	14.86	30.04	33.70	14.84	26.82

C: GPRS Pattern:

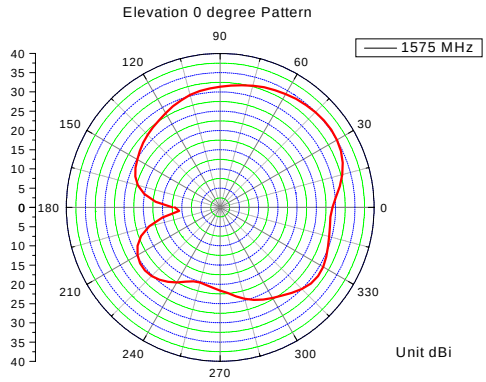
GPRS pattern in Azimuth plane

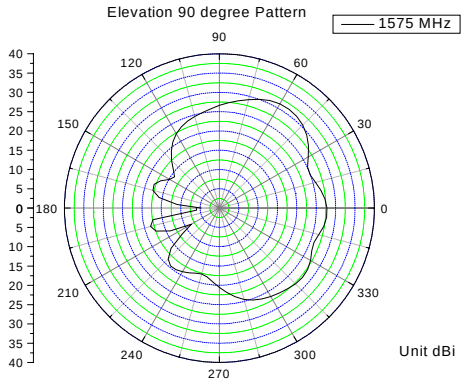


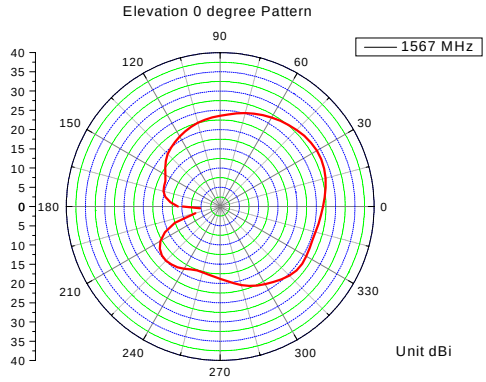


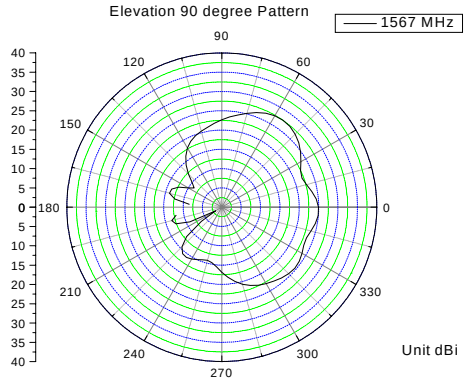
D: GPS Pattern

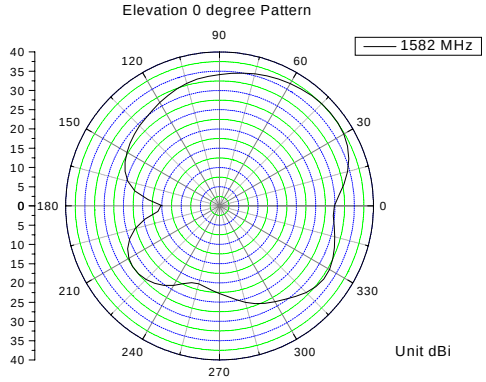
GPS Pattern in Elevation 0 degree:

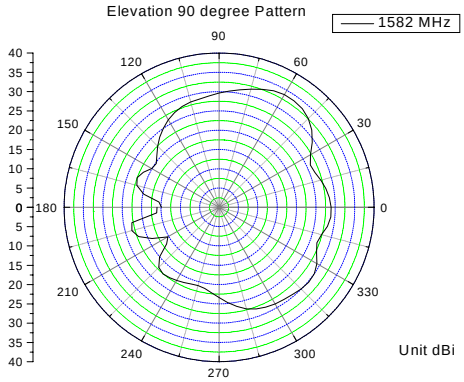












IV. The Coupling Effect for The Two Antennas:

The GSM power will coupling vie the GPRS antenna to the GPS LNA. The power of the GSM will compress the gain for the LNA.

Using the R&S SMIQ to generate GSM signal in 1710 MHz we measure the Active GPS gain. We see no gain degrading for the GPS LNA. The LNA have little spurious signal around the band and those come from the unstable in the upper and lower band far away from the scope we can see. The noise from the PCB coupling is

also the problems for this.

V. Summary for measurement and Specification for the Module:

A. The pattern for GPRS is omi-directionl and is good for the application.

B. The GPS Pattern Max. Point till 30 degree and it's comes form the ground plane and the unbalance pattern for the GPS.

C. The GPS LNA can stand the GSM output power less than 28 dBm in 1710 MHz.

Parameter	Electrical Specifications
Frequency Range	1573.42~1577.42 MHz
Patch Antenna Polarization	RHCP
VSWR (50ohm)	< 2.0
Elevation Patch Antenna Axial Ratio at θ=0 degree (dBic)	< 3
Elevation maximum patch Antenna Gain or directive (dBic)	3 dBic
Elevation Pattern	Hemispherical
LNA DC Voltage	3.3~5V
LNA DC Current	25 mA Max.
LNA Amplifier Gain (dB)	3.3 V: 23 5.0 V: 25
Noise Figure including filter and LNA @ ambient temperature	2.5 Typical
LNA input near 1575 MHz P1dB	< -10 dBm
Isolation between the GPS patch including first stage filter and the GPRS antenna @1710~1990 MHz and @ 915~824 MHz	-45dB Min.
Testing Condition	1. The patch Antenna gain is the gain at the feed point of the antenna; do not include the cable and the connector. 2. The measurement shall be taken on the 30 cm diameter ground plane.

Table 1: The GPS Active antenna specification

Parameter	Electrical Specifications
Frequency Range	880~960 MHz (GSM), 1710~1880MHz (DCS), 1850~1990 MHz (PCS)
VSWR (50 Ohm)	< 2.5 @1710~1990; < 3.5 @ 880~960
Polarization	Vertical
Peak Gain (Total power Gain)	~2dBi Typ.
Azimuth average typical gain (dBi)	~-1dBi

Azimuth Pattern	Omni-directional
Power Handling (W)	>10
Testing conditions	1. All the measurement shall be taken on 30 cm diameter ground plane 2. The antenna gain is defined at the antenna feed point, not including the cable loss.

Table 2. The GPRS antenna specification.