GWN7672 - Antenna Radiation Patterns

Introduction

One of the major components of a wireless Access Point is the antenna. These radio components come in different shapes and sizes to fit specific deployment needs, and each access point can bundle multiple antennas for sending and receiving signals in order to benefit from the MIMO (Multiple Input/Multiple Output) technology and obtain higher throughput and signal resilience, also the arrangement of multiple antennas internally to a single WLAN access point can be used to influence the shape and behavior of the wireless signal (both on transmit and receive). To better understand how each GWN access point model broadcasts the wireless signals, this paper provides radiation patterns to help engineers during the deployment process.

The GWN7672 is a powerful enterprise-grade Wi-Fi 7 access point that provides speeds up to 11 Gbps (BE11000). It ensures maximum network throughput and provides expanded Wi-Fi coverage range thanks to tri-band 2×2:2 MU-MIMO with DL/UL Enhanced OFDMA technology and a sophisticated antenna design. The GWN7672 improves bandwidth utilization and anti-interference with Multi-Resource Units (MRU) and Preamble Puncturing technology, provides a significant increase in data transfer rates through 4096 QAM, and optimizes spectrum resource utilization to ensure a smooth user experience through Multi-Link Operation (MLO) technology.

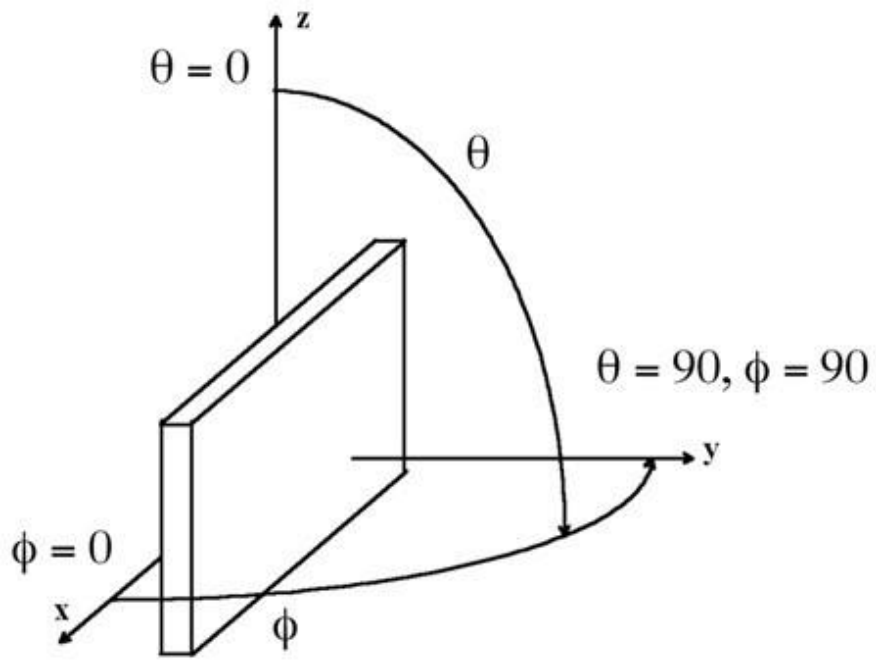
This model offers hybrid management flexibility through its local web UI or cloud-based platforms like GDMS Networking and GWN Manager. It is the ideal Wi-Fi AP for voice-overWi-Fi deployments and offers a seamless connection with Grandstream's Wi-Fi-capable IP phones. Engineered for high-density environments, this Wi-Fi access point supports up to 384 concurrent clients with ease. It ensures flawless realtime performance through advanced QoS and low-latency optimization, while offering the versatility of mesh networking and captive portals. Featuring Bluetooth 5.3 and dual 5 GbE PoE+ ports, it delivers the high-speed backhaul and IoT connectivity essential for demanding wireless deployments.

Terminology

In this first part, we will provide a quick review of some fundamental concepts related to antennas and radio propagation:

Antenna: An antenna is a transducer between a feed signal and a radiated wave over space; it is usually attached to a transmitter/receiver unit, and the radiated energy is characterized by the antenna's radiation pattern.

Antenna pattern: The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna and how it radiates energy out into space or how it receives energy (reciprocity). An antenna radiates energy in all directions, at least to some extent, so the antenna pattern is actually three-dimensional. It is common, however, to describe this 3D pattern with planar patterns called the principal plane patterns. These principal plane plots are commonly referred to as antenna radiation patterns.



Polar Coordinates

Isotropic radiator: An isotropic radiator is a hypothetical lossless antenna that radiates its energy equally in all directions. This imaginary antenna would have a spherical radiation pattern and the principal plane cuts would both be circles since any plane cut through a sphere would be a circle.

Gain: The gain of an antenna (in a given direction) is defined as the ratio of the power gain in that direction to the power gain of a reference antenna in the same direction; usually an isotropic radiator is set as reference, and the value of the gain is expressed in dBi. It is important to state that an antenna with gain doesn't generate power and it does simply directs the way the radiated power is distributed relative to radiating the power equally in all directions; thus the gain is just a characterization of the way the power is radiated.

Efficiency: The efficiency of an antenna is the ratio of the power delivered to the antenna relative to the power radiated from the antenna. A high-efficiency antenna has most of the power present at the antenna's input radiated away. A low-efficiency antenna has most of the power absorbed as losses within the antenna or reflected away due to impedance mismatch, which causes an antenna to not have an efficiency of 100%.

Antenna efficiency losses are typically due to:

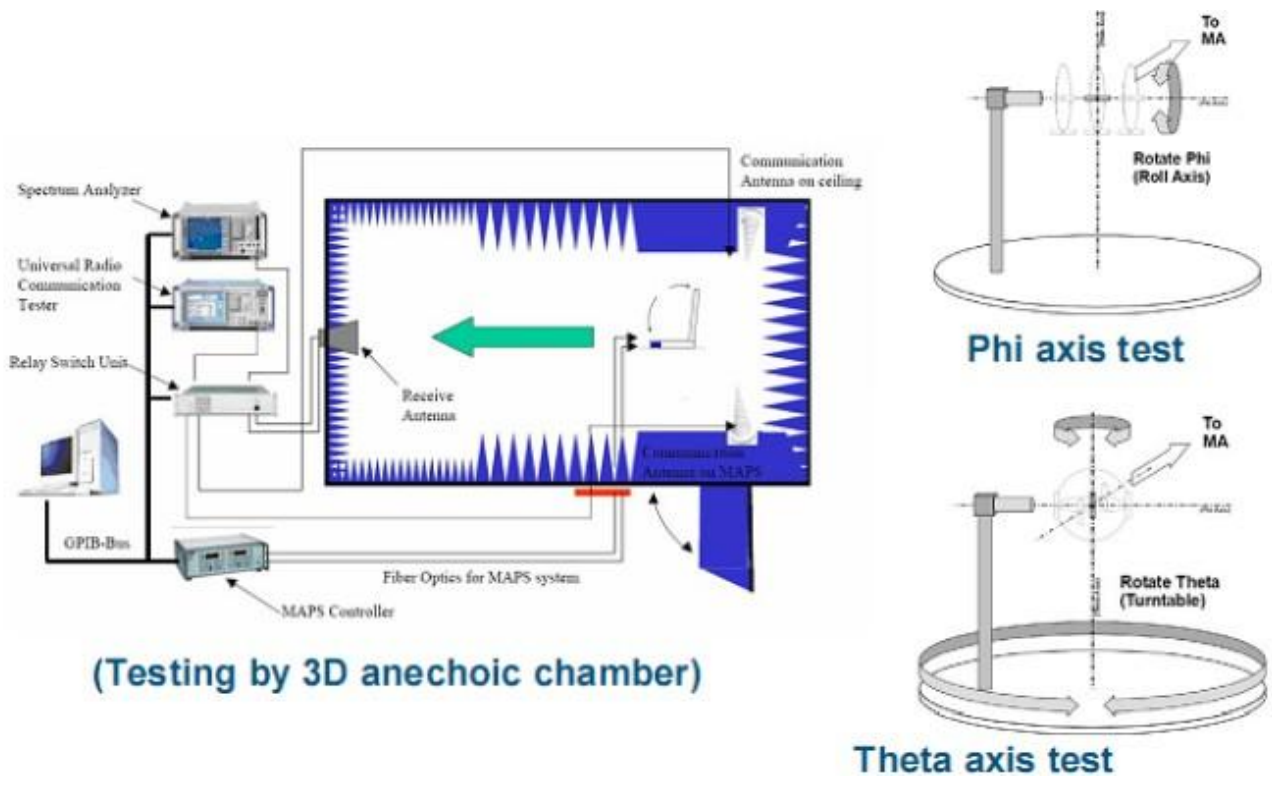
- Conduction losses (due to finite conductivity of the metal that forms the antenna).
- Dielectric losses (due to the conductivity of a dielectric material near an antenna).
- Impedance mismatch loss.

Test environment

This test report gives schematic diagrams with antenna distribution of the GWN7672 access point, along with the antenna radiation patterns of 2.4Ghz, 5Ghz, or 6Ghz frequencies in order to help engineers during the deployment process.

Please note that these radiation patterns are gathered in a fully anechoic environment. Their shape will change in installed environments depending on the obstacles that the wireless signal might face. Every deployment will behave differently due to materials, geometries of structures, etc, and how these materials behave at 2.4GHz, 5GHz, and 6GHz.

The figure below gives an overview of the test environment used:



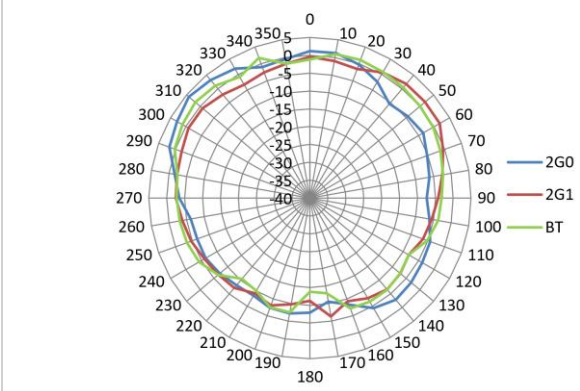
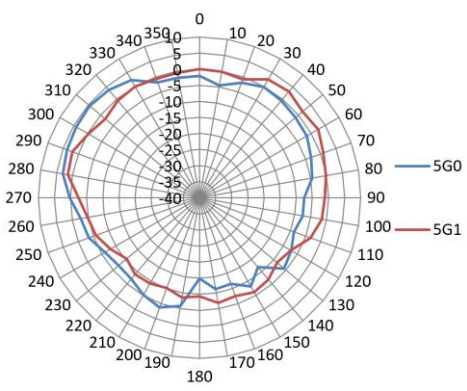
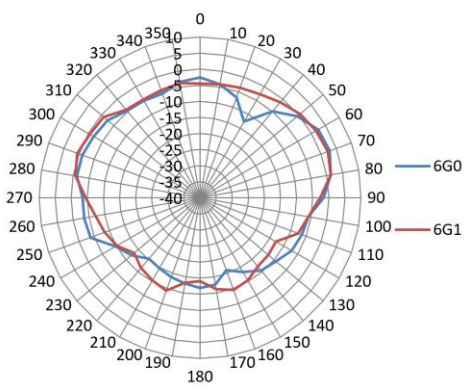
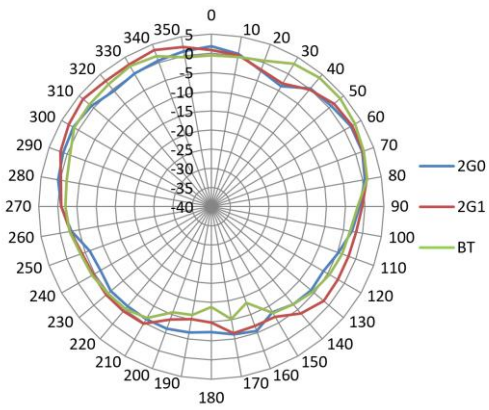
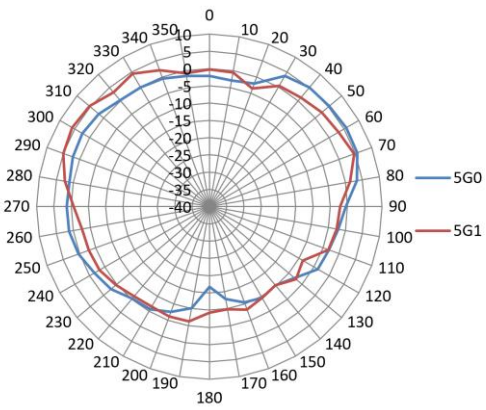
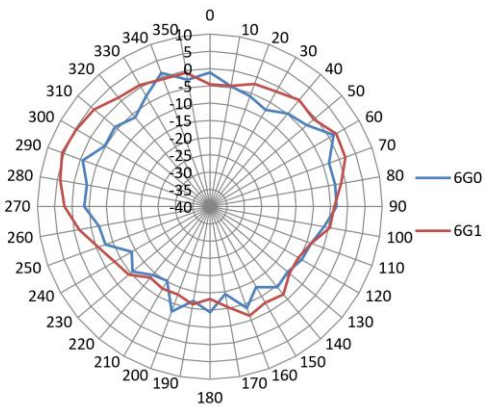
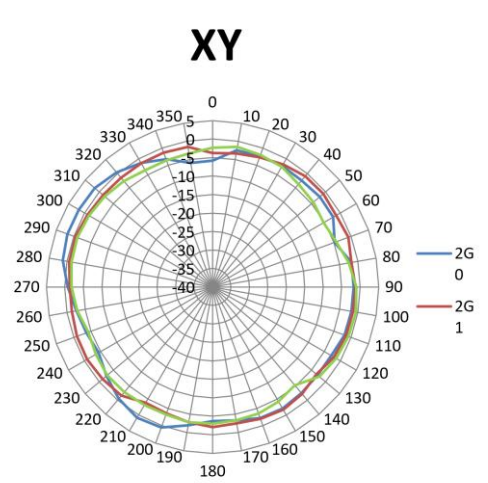
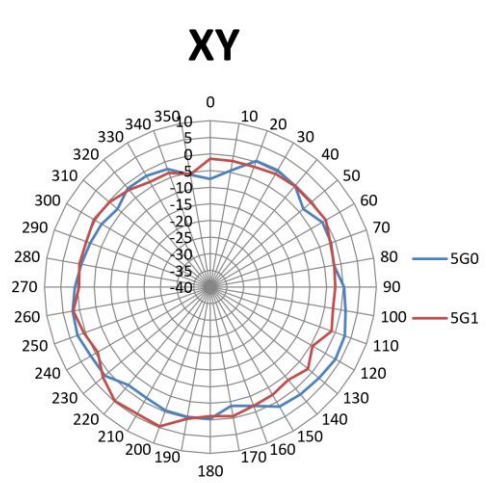
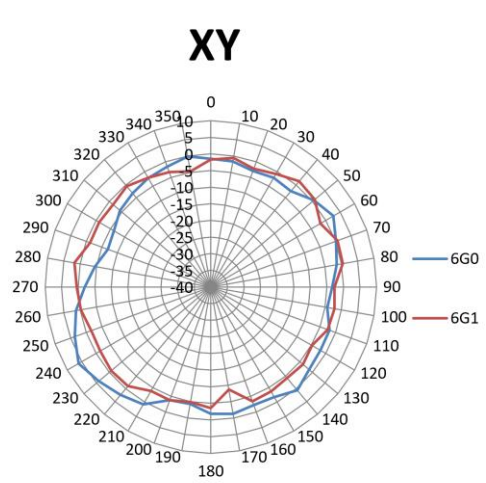
Test Environment

GWN7672 Antenna Characteristics

Antenna Patterns

This section presents the antenna radiation patterns of the GWN7672 access point based on conducted testing. The plots are shown in the XZ and YZ planes, which correspond to the vertical (elevation) views, and in the XY plane, which corresponds to the horizontal (azimuth) view.

Label	2.4G	5G	6G

Phi=0(deg) **XZ**			
Phi=90(deg) **YZ**			
Theta=90(deg) **XY**			

GWN7672 Antenna Radiation Patterns

Tabular Antenna Gain Data

To complement the visual plots provided above, the following tables detail the precise numerical antenna gain values (measured in dBi) for the GWN7672 access point. This raw data represents the signal strength distribution mapped at 10-degree increments across a full 360-degree radius. The values are categorized by frequency band (2.4 GHz and 5 GHz), the specific internal MIMO antennas (such as 2G0 and 2G1), and the respective measurement planes (XZ, YZ, and XY).

- **2.4G Antenna Gain Data**

	Phi=0(deg) XZ			Phi=90(deg) YZ			Theta=90(deg) XY		
Angle	**2G0**	**2G1**	**BT**	**2G0**	**2G1**	**BT**	**2G0**	**2G1**	**BT**
0	1.2	-0.4	-1.2	1.8	0.8	-0.5	-5.8	-3.8	-2.3
10	1.3	-1	0.9	0.5	0.2	-0.4	-2.5	-3.3	-1.5
20	-0.2	-1.5	1.2	-2.3	-2	0.5	-2.3	-2.7	-2
30	-2.4	-2.11	0.8	-3.7	-2.9	3	-2.2	-1.7	-2.5
40	-5.5	-1.76	0.5	0.2	-0.2	3.8	-2.4	-0.9	-3.8
50	-4.4	-0.33	0.1	0.8	1.8	3.86	-2	-0.8	-4.3
60	-3.5	0.35	-0.3	2	2.3	3.2	-2.2	-1.3	-5.2
70	-5.2	0.86	-1.2	1.8	2.1	2.3	-4.8	-0.8	-4.3
80	-6.1	1.24	-2.3	0.6	1.1	1.2	-1.8	-1.8	-2.5

90	-7.4	1.79	-3.2	-1.4	-0.7	-1.9	-1.7	-1.2	-1
100	-6.2	-0.24	-3.7	-2.8	-1.7	-3.3	-1.8	-1.4	-0.5
110	-4.3	-3.92	-5.2	-4.8	-2	-3.8	-1.9	-1.5	-0.8
120	-3.8	-5.17	-8.2	-6.3	-1.9	-4.5	-2.9	-2	-1.3
130	-3.2	-2.25	-7.2	-6.1	-1.8	-5.5	-2.9	-3.3	-2.2
140	-2.8	-1.66	-6.5	-6.8	-3.7	-6.8	-2.5	-2.2	-5.3
150	-4.4	-1.72	-6.5	-8.2	-6.8	-7.9	-2	-1.7	-4.2
160	-8.3	0.89	-7.1	-5.5	-6.9	-13.3	-2.2	-2	-3.5
170	-10.6	-2.12	-13	-6.2	-6.5	-10.2	-3.3	-2.5	-3.3
180	-7.9	-11.53	13.8	-7.3	-9.8	-13.8	-3.7	-2.1	-3
190	-7.2	-5.63	-7.5	-6.7	-10.2	-11.3	-2	-2.8	-2.8
200	-7.3	-2.35	-7.5	-6.1	-8.7	-10.7	0.5	-3.5	-3.2
210	-8.5	1.13	-10	-6.1	-4.7	-6.5	0.9	-3.8	-3.1
220	-8.1	2.74	-10.5	-6.1	-4.4	-5.2	-0.5	-1.6	-2.8
230	-7.1	0.76	-6.5	-5.8	-4.2	-4.8	-2.5	-1.2	-2.8
240	-6.4	-2.73	-4.3	-6.7	-4.5	-4.1	-4.4	-0.8	-3.5
250	-6.5	-0.65	-3.5	-6.3	-4.2	-3.8	-3.6	-0.9	-4.2
260	-6.2	1.34	-3.1	-3	-2.7	-2.5	-2.6	-1.3	-2.8
270	-3.5	0.66	-2.8	-0.9	-0.9	-2	-0.8	-1.3	-1.8
280	-1.7	-2.26	-2.4	0.5	-0.2	-1.7	1.2	-0.6	-1.2
290	1.8	-1.88	0.2	1.1	1.8	-0.8	1.8	-0.4	-1
300	2.9	0.45	1.2	1.5	2.9	1.2	1.8	-0.9	-1.4
310	4.18	0.11	1.8	0.8	3.65	1.5	1.6	-1.3	-1.85
320	3.1	-1.86	1.1	-0.6	2.8	1.6	0.5	-1.5	-2.6
330	1.8	-1.89	-0.8	0	2.8	2.3	-1.3	-1.4	-3.5
340	-1	-0.47	1.7	0.5	3.5	1.8	-3.2	-1.3	-3.5
350	-0.5	-0.85	-1.8	1.2	2.3	-0.5	-5.9	-1.5	-3.3

- **5G Antenna Gain Data**

	Phi=0(deg) XZ		Phi=90(deg) YZ		Theta=90(deg) XY	
Angle	**5G0**	**5G1**	**5G0**	**5G1**	**5G0**	**5G1**
0	-2.1	-0	-2.1	-0.3	-7.5	-1.5
10	-4.5	-0.2	-2.9	-0.5	-4.5	-1.6
20	-1.9	-0.8	-2.1	-3.6	0.3	-1.5
30	-0.2	-2.5	3.8	0.4	0.5	-0.8
40	-0.6	3.2	5.1	1.2	-0.3	-0.4
50	-1.1	1.7	5.3	2.5	-3.5	-0.5
60	-1.5	2.5	5.73	3.2	-1.1	0.2
70	-3.2	0.9	5.6	4.6	-1.3	-1.5
80	-4.5	-0.2	3.4	1.4	-2.2	-2.1
90	-7.5	-1.1	-0.5	-2.1	0.3	-2.4
100	-7.5	-1.5	-2.1	-2.5	1.3	-2.5
110	-8.8	-3.4	-3.2	-3.3	3.1	-1.2
120	-7.1	-7.3	-3.8	-8.7	3.5	-4.5
130	-5.8	-8.6	-7.8	-7.3	2.7	-1.6
140	-11.8	-6.8	-10.2	-10.2	2.2	-3.5
150	-8.2	-6.1	-9.5	-9.5	1.6	-2.5
160	-11.5	-7.5	-10.5	-8.2	-2	-2
170	-11.2	-6.8	-12.8	-9.8	-3.7	-0.5
180	-14.9	-9.3	-16.8	-9.3	-0.4	-1.1
190	-5.8	-8.5	-10.2	-6.2	-0.3	0.3
200	-3.7	-10.2	-7.5	-6.1	-0.5	4.6
210	-5.2	-9.2	-5.7	-6.6	-1.5	4.1
220	-7.1	-8.9	-5.2	-6.1	-1.5	4.8
230	-7.2	-10.5	-2.8	-4.7	1.5	2.2
240	-6.1	-8.1	-1.6	-3.3	1.5	-0.8
250	-3.5	-5.8	0.3	-2.6	2.5	0.5

260	-2.6	-4.8	1.3	-2.5	2.1	1.9
270	0.3	-2.5	1.3	-0.7	0.8	-0.5
280	3.1	1.5	1.1	2.5	-0.5	0
290	3.7	1.9	2.1	5.03	-1.5	-0.2
300	4.2	-0.2	2.5	5.85	-2.2	0.5
310	4.5	-1.9	1.8	5.3	-3.5	-0.3
320	3.8	-0.5	0.2	3.2	-1.3	-1.9
330	2.3	-0.1	-0.1	4.52	-1.5	-3.6
340	-1.8	-0.6	-0.5	2.03	-2.3	-3.5
350	-2.1	-0.5	-1.5	-0.8	-5.7	-5.6

- **6G Antenna Gain Data**

	Phi=0(deg) XZ		**Phi=90(deg) YZ**		**Theta=90(deg) XY**	
Angle	**6G0**	**6G1**	**6G0**	**6G1**	**6G0**	**6G1**
0	-2.5	-4.4	-1.1	-4.6	-1.5	-1.7
10	-4.2	-4.2	-4.6	-4.5	-1.7	-0.6
20	-6.8	-3.5	-5.9	-2.2	-2.9	-2.2
30	-12.7	-2.8	-7.6	-1.5	-2.1	-0.8
40	-4.9	-1.2	-4.8	0.3	-2.4	-1.5
50	-0.6	0.5	-3.3	-0.6	0.6	0.9
60	2.4	1.6	1.5	2.3	2.7	-1.8
70	2.9	2.2	-3.2	1.8	0.2	0.6
80	1.2	1.2	-3.1	-1.3	-1.5	0.4
90	-1.6	-2.7	-3.2	-3.9	-3.4	-2.7
100	-5.8	-5.8	-6.4	-4.7	-4.3	-2.1
110	-6.3	-7.6	-8.7	-8.7	-1.9	-2.5
120	-7.2	-12.8	-9.3	-10.4	-1.8	-4.8
130	-9.2	-12.3	-10.5	-9.8	-1.3	-3.8
140	-10.5	-12.1	-9.5	-6.8	0.6	-4.2
150	-13.4	-10.3	-13.1	-7.8	-1.8	-3.7
160	-16.1	-9.5	-8.7	-6.4	-2.2	-3.4
170	-12.6	-11.1	-14.3	-10.5	-1.3	-8.7
180	-12	-14.1	-9.4	-13.2	-1.8	-3.6
190	-12.9	-13.2	-12.3	-11.3	-4.3	-4.8
200	-13.8	-9.2	-7.7	-12.9	-3.8	-3.8
210	-14.7	-10.3	-15.2	-12.6	0.8	-3.9
220	-15.3	-11.5	-14.1	-13.2	2.4	-1.1
230	-12.2	-13.3	-10.7	-9.3	4.1	-0.8
240	-9.8	-10.2	-13.8	-8.1	6.05	-1.5
250	-3.8	-8.5	-7.8	-5.6	3.7	-1.6
260	-3.5	-7.1	-7.4	-1.5	1.3	-0.2
270	-3.5	-4.5	-3.6	2.2	-1.9	0.5
280	-1.2	-0.7	-3.8	4.1	-4.5	1.8
290	-1.1	0.6	-0.7	5.63	-6.9	-1.2
300	-1.8	-0.5	-4.8	4.7	-6.2	-1.1
310	-2.5	-0.9	-4.1	3.8	-4.2	-1.5
320	-4.7	-4.2	-6.3	1.3	-3.3	-0.5
330	-5.1	-4.7	-3	0.7	-2.2	-2.1
340	-5.6	-4.4	1.2	-0.6	-1.5	-3.3
350	-3.4	-3.8	-2.7	-0.6	-0.2	-4.7