

Grandstream Networks, Inc.

GWN7660EM

Antenna Radiation Patterns



GWN7660EM - 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 GWN7660EM is an AX3000 Wi-Fi 6 access point with a socket design, enabling simple deployment and high-performance wireless connectivity. It supports dual-band Wi-Fi 6 with 2x2:2 MU-MIMO technology on the 2.4 GHz band and 3x3:2 MU-MIMO on the 5 GHz band. Combined with a sophisticated antenna design and XTRA Range technology with beamforming, it delivers maximum network throughput and extended Wi-Fi coverage.

The GWN7660EM can also operate as a wireless extender, working with the GWN7062E/ET and future Grandstream routers to quickly build a home wireless mesh network and expand wireless coverage throughout the home.

For simplified deployment and management, the GWN7660EM uses a controller-less distributed architecture with the controller embedded in its web interface. It also supports Grandstream's GDMS Networking and GWN Manager. With seamless integration with Grandstream Wi-Fi IP phones, advanced QoS, low-latency real-time application support, mesh networking, captive portals, support for up to 128 concurrent clients per AP, and one Gigabit Ethernet port, the GWN7660EM is an ideal Wi-Fi access point for small and medium household users seeking high-speed Wi-Fi coverage throughout the home.

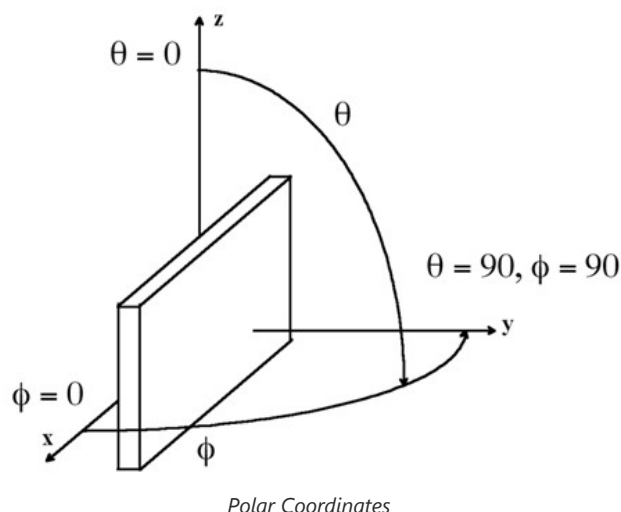
We begin this report with a glossary of basic definitions related to antennas' radio characteristics and then progress through the specific radiation patterns for the GWN7660EM access point series.

Terminology

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

Antenna: An antenna is a transducer between a feed signal and radiated wave over the 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.



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 direct 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:

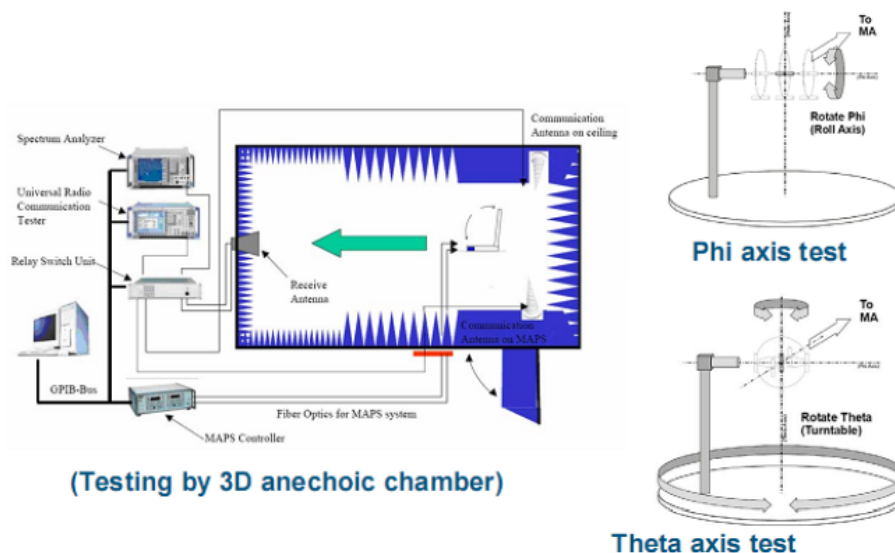
- Conduction losses (due to finite conductivity of the metal that forms the antenna).
- Dielectric losses (due to the conductivity of a dielectric material near an antenna).
- Impedance mismatch loss.

Test environment

This test report gives schematic diagrams with antennas distribution of GWN7660EM access points series, along with the antenna radiation patterns of 2.4Ghz, 5Ghz 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 and 5GHz.

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

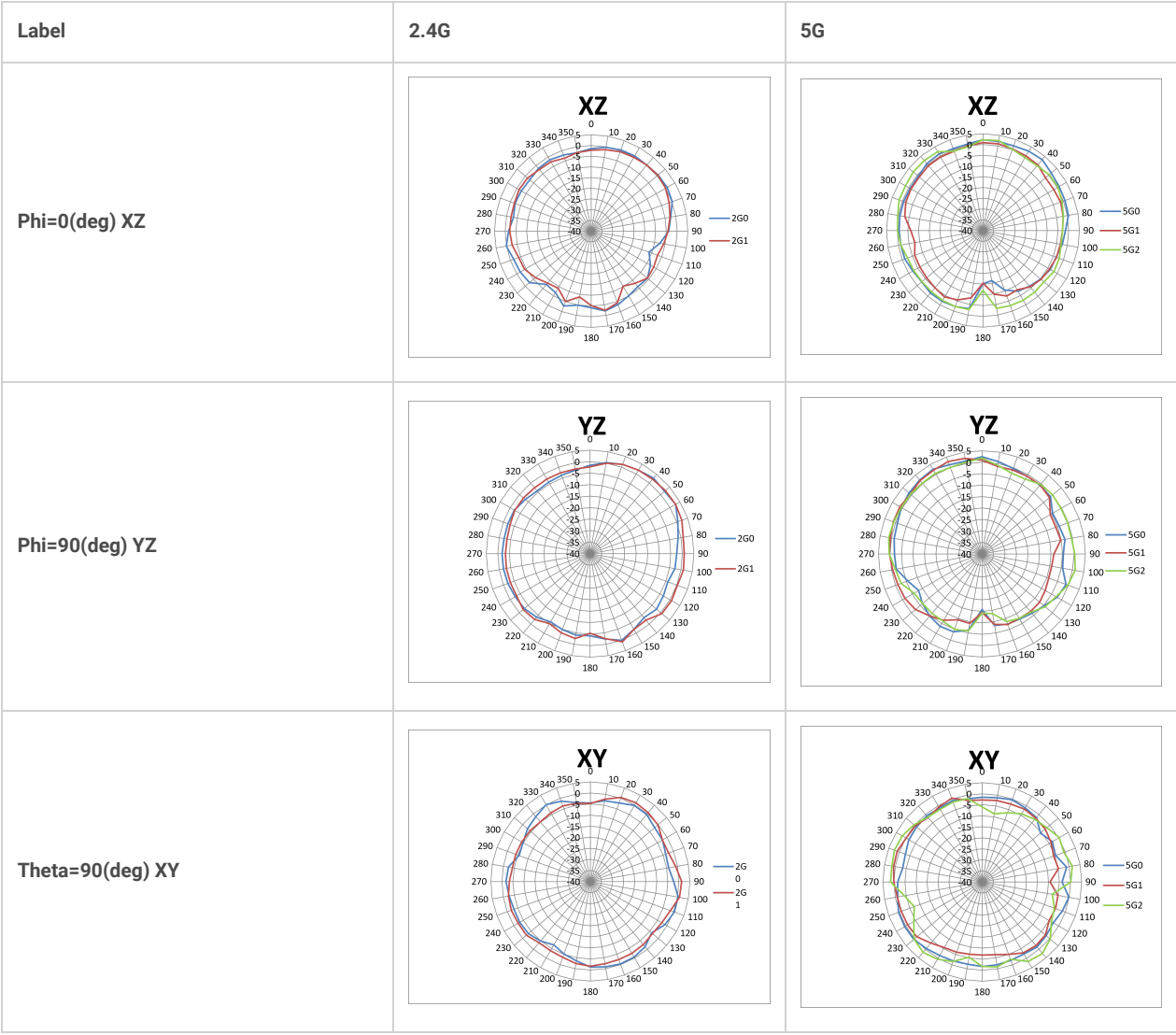


Test Environment

GWN7660EM Antenna Characteristics

Antenna Patterns

This section presents the antenna radiation patterns of the GWN7660EM 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.



GWN7660EM 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 GWN7660EM 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).

o 2.4G Antenna Gain Data

	Phi=0(deg) XZ		Phi=90(deg) YZ		Theta=90(deg) XY	
Angle	2G0	2G1	2G0	2G1	2G0	2G1
0	-1.45	-2.21	-1.55	-2.25	-4.53	-4.65
10	-0.23	-1.45	0.23	-0.13	-2.95	-2.23
20	0.33	-0.57	1.34	1.26	-2.16	0.45
30	0.56	-0.23	1.87	1.86	-0.25	1.13
40	0.24	0.27	2.78	2.25	-0.47	0.64

50	0.67	0.59	2.13	2.66	-2.06	-0.12
60	0.88	-0.04	2.86	2.86	-2.45	-2.36
70	0.16	-1.36	0.54	2.34	-3.74	-2.38
80	-2.38	-2.68	-1.27	0.97	-4.13	-0.83
90	-3.95	-4.26	-2.43	0.84	-2.39	1.22
100	-7.47	-5.67	-2.58	1.07	0.22	0.9
110	-11.28	-7.15	-4.13	0.25	0.37	-1.55
120	-8.12	-6.36	-3.28	0.86	-1.03	-2.73
130	-5.77	-5.84	-2.37	0.65	-3.86	-3.38
140	-6.11	-8.23	-3.65	-2.27	-1.47	-2.76
150	-5.12	-10.25	-2.03	-1.9	-0.49	-2.47
160	-3.47	-4.33	0.07	0.84	-0.35	-2.42
170	-2.13	-2.47	-2.31	-2.53	-0.77	-2.25
180	-4.15	-5.26	-4.24	-5.38	-1.32	-1.74
190	-4.89	-8.78	-4.05	-2.5	-3.56	-2.38
200	-2.75	-4.98	-4.86	-3.37	-5.13	-3.56
210	-6.86	-9.23	-5.76	-4.87	-6.89	-3.88
220	-7.55	-8.28	-3.87	-2.64	-4.88	-3.8
230	-2.58	-6.16	-2.86	-2.13	-3.38	-2.23
240	-1.89	-4.25	-2.56	-3.15	-3.13	-2.28
250	-1.57	-4.07	-2.12	-3.21	-3.27	-1.92
260	0.14	-2.68	-1.85	-3.17	-2.68	-2.33
270	-1.58	-2.05	-1.83	-3.29	-1.86	-3.34
280	-3.24	-2.13	-2.14	-3.45	-2.42	-4.26
290	-2.26	-1.97	-2.03	-3.13	-5.69	-4.14
300	-2.45	-1.18	-2.12	-2.36	-4.84	-4.21
310	-2.64	-1.39	-3.35	-2.27	-2.85	-4.36

320	-1.79	-2.42	-4.36	-2.64	-1.63	-4.75
330	-1.56	-2.65	-4.15	-2.55	0.12	-4.24
340	-2.24	-3.75	-3.79	-2.57	-1.35	-3.63
350	-2.78	-2.76	-3.13	-2.61	-3.77	-4.1

o 5G Antenna Gain Data

	Phi=0(deg) XZ			Phi=90(deg) YZ			Theta=90(deg) XY		
Angle	5G0	5G1	5G2	5G0	5G1	5G2	5G0	5G1	5G2
0	2.23	0.88	2.24	2.35	0.87	1.82	-1.52	-2.85	-5.98
10	2.12	0.97	2.46	0.96	-1.21	-0.71	-1.15	-2.46	-8.67
20	1.95	0.43	0.24	-0.26	-1.06	-2.56	-0.36	-2.35	-6.62
30	2.67	0.12	-0.84	-0.85	-0.85	-2.34	-1.13	-1.86	-4.3
40	3.06	-0.14	-0.73	-0.9	-0.66	-0.35	-1.75	-2.24	-2.92
50	1.64	-1.85	0.45	-1.04	-1.74	0.11	-5.5	-2.65	-1.71
60	1	-1.85	0.37	-4.55	-5.65	-0.33	-3.37	-4.05	0.27
70	0.78	-1.44	-0.74	-4.21	-5.84	-0.35	-4.63	-5.58	-0.65
80	0.45	-2.03	-1.92	-3.34	-5.23	-0.45	-1.2	-4.91	1.48
90	-1.5	-2.86	-2.85	-4.66	-8.65	0.31	-3.84	-9.24	0.14
100	-2.43	-3.32	-2.96	-4.34	-9.22	1.13	-0.12	-5.15	-7.78
110	-3.68	-3.45	-2.04	-1.12	-9.13	-0.28	-1.36	-4.72	-5.19
120	-3.71	-4.2	-1.66	-2.25	-8.24	-2.77	-2.84	-5.05	-3.83
130	-4.84	-4.67	-2.75	-4.77	-7.3	-4.2	-2.21	-2.63	0.26
140	-6.18	-5.75	-2.45	-6.2	-7.21	-6.83	-1.45	-2.25	2.38
150	-7.36	-8.04	-2.44	-7.25	-7.56	-7.56	-2.33	-2.85	1.64
160	-10.5	-7.5	-2.73	-7.47	-7.24	-8.59	-2.2	-5.03	-2.71
170	-16.24	-9.83	-3.13	-8.38	-8.87	-13.56	-1.84	-6.54	-0.86
180	-15.26	-15.4	-12.18	-15.8	-14.53	-14.18	-1.65	-6.81	-1.63

190	-3.03	-8.15	-2.59	-6.23	-9.24	-5.9	-2.13	-6.76	-5.36
200	-2.35	-5.62	-2.31	-3.85	-9.51	-5.04	-1.85	-6.14	-1.61
210	-1.86	-4.23	-2.41	-3.57	-6.62	-6.24	-1.45	-5.65	0.49
220	-1.95	-5.14	-2.72	-4.68	-4.71	-6.18	-0.56	-3.74	1.65
230	-2.74	-5.72	-2.94	-6.28	-2.27	-6.33	0.5	-1.32	0.35
240	-2.27	-6.08	-2.67	-8.16	-1.35	-5.91	0.55	-1.03	-4.24
250	-1.25	-6.12	-2.54	-5.63	-1.09	-2.5	0.37	-0.94	-7.23
260	-1.06	-7.76	-1.07	-2.13	-0.51	-1.75	-1.12	-0.86	-4.15
270	-0.84	-6.32	-0.15	-1.89	0.23	0.39	-1.72	0.07	1.54
280	-0.66	-3.04	0.37	-1.24	0.47	1.23	-3.36	0.76	1.66
290	-0.63	-1.66	1.56	-0.85	1.03	0.84	-2.92	1	2.32
300	-0.78	-1.22	1.65	0.55	1.15	0.53	-1.61	-0.23	1.91
310	-0.65	-1.18	2.46	1.37	0.66	0.55	-1.15	-0.36	0.37
320	0.67	-0.54	2.57	2.12	1.82	0.34	-0.83	-1.82	-1.62
330	1.05	-0.48	2.34	2.65	2.12	0.57	-1.35	-0.78	-1.88
340	0.52	-0.64	-0.67	1.35	2.88	0.11	-0.73	0.44	-1.45
350	0.9	0.14	-0.28	1.12	2.33	0.64	-1.71	-2.46	-1.57