

Antenna Gain Information: GMN-03002

Equipment Description:

This report contains the antenna gain information for the Wi-Fi /Bluetooth antennas used by Garmin Model GMN-03002.

The GMN-03002 includes two identical dual-band Wi-Fi/Bluetooth antennas, placed internally along the edge of the bezel.

The antenna design is based on a 2450 MHz dipole element with a secondary element that is resonant to 5150 MHz. The design provides support for operating frequencies between 2402-2480 MHz and 5150-5250 MHz. The maximum gain is reported for each frequency band.

Reported Data:

2400-2480 MHz Maximum Gain: **8 dBi @ 2402 MHz**

5150-5250 MHz Maximum Gain: **-4.4 dBi @ 5150 MHz**

Setup Description:

Garmin used an Open-Air Test (OAT) setup to measure the antenna gain of the EUT. A three antenna gain calculation method was implemented with the EUT and two horn antennas. Measurements were taken with the following antenna combinations positioned 12 feet (3.6576 meters) apart, each at a height of 34 inches.

1. EUT (Transmitting) to Horn 1 (Receiving)
2. EUT (Transmitting) to Horn 2 (Receiving)
3. Horn 1 (Transmitting) to Horn 2 (Receiving)

EUT to was modified to provide a conducive path for an RF generator to provide a signal to the antenna. The same signal was used by Horn 1 in the third configuration listed above. While monitoring the radiated signal the EUT position was adjusted to find the orientation with the highest measured radiated signal strength.

Measurements were taken with the receiving horn antennas in both a horizontal and vertical orientation.

Calculations:

The 3-antenna calculation system relies on the generalized Friss Transfer Equation provided below.

$$P_r^{[dB]} = P_t^{[dB]} + G_t^{[dBi]} + G_r^{[dBi]} + 20 \log_{10} \left(\frac{\lambda}{4\pi d} \right)$$

Where:

P_r : Power received in mW

P_t : Power transmitted in mW

G_t : Gain of transmitting antenna in dBi

G_r : Gain of receiving antenna in dBi

λ : Wavelength of frequency in meters

d : Distance between antennas in meters

Note: Wavelength is calculated as speed of light = 299792458 m/s divided by frequency (e.g. 2402 MHz).

More specifically this results in the following equations

$$G_1 \text{ dB} + G_2 \text{ dB} = 20\log_{10}\left(\frac{4\pi R}{\lambda}\right) + 10\log_{10}\left(\frac{P_r}{P_t}\right)$$

$$G_1 \text{ dB} + G_3 \text{ dB} = 20\log_{10}\left(\frac{4\pi R}{\lambda}\right) + 10\log_{10}\left(\frac{P_r}{P_t}\right)$$

$$G_2 \text{ dB} + G_3 \text{ dB} = 20\log_{10}\left(\frac{4\pi R}{\lambda}\right) + 10\log_{10}\left(\frac{P_r}{P_t}\right)$$

Where:

G_1 : Gain EUT antenna in dBi

G_2 : Gain of 1st Horn Antenna in dBi

G_3 : Gain of 2nd Horn Antenna in dBi

P_r : Power received in mW

P_t : Power transmitted in mW

λ : Wavelength of frequency in meters

R : Distance between antennas in meters

Each combination of antennas is then assigned as A, B or C.

$$G_1 \text{ dB} + G_2 \text{ dB} = A$$

$$G_1 \text{ dB} + G_3 \text{ dB} = B$$

$$G_2 \text{ dB} + G_3 \text{ dB} = C$$

The gain of each antenna can then be solved as follows:

$$G_1 \text{ dB} = \frac{A + B - C}{2},$$

$$G_2 \text{ dB} = \frac{A - B + C}{2},$$

$$G_3 \text{ dB} = \frac{-A + B + C}{2}.$$

Setup:

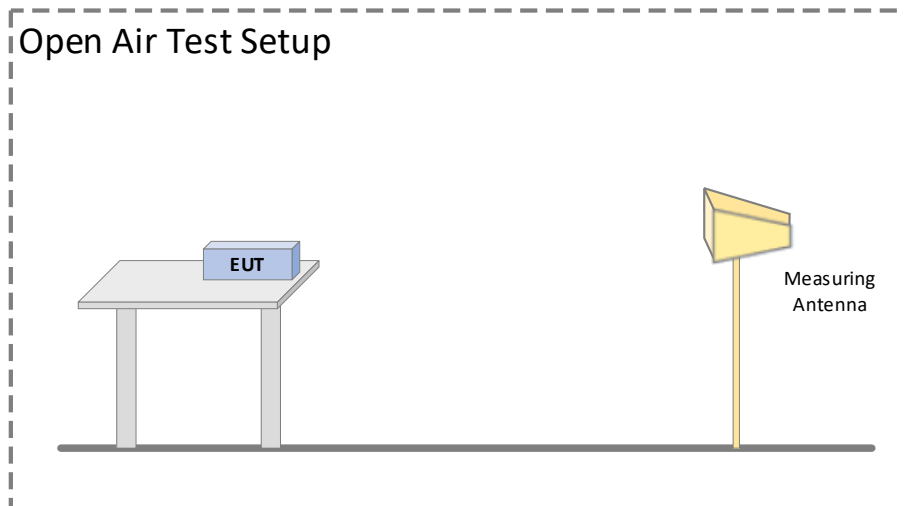


Figure 1 - EUT to Horn 1/Horn 2 Antennas

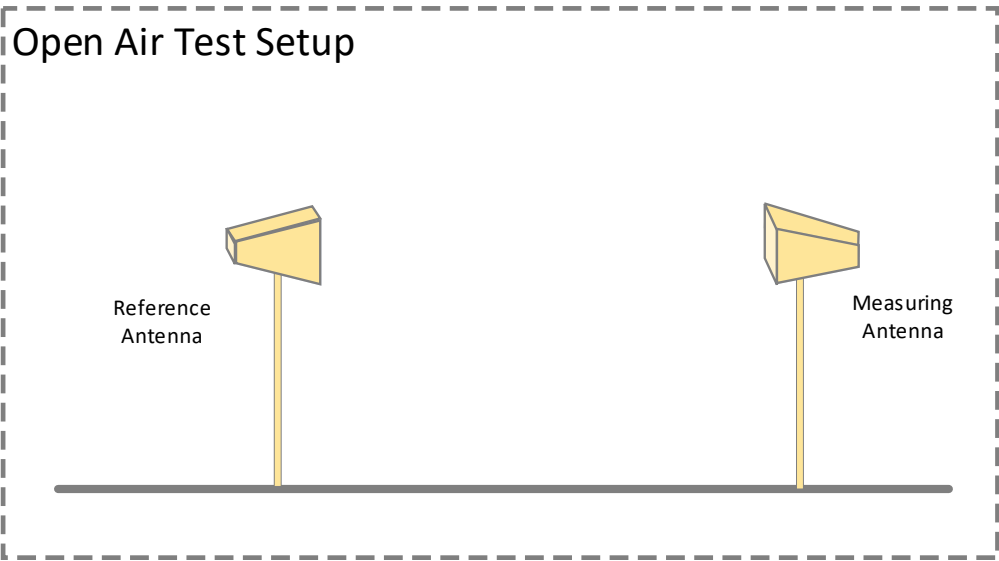


Figure 2 - Horn 1 to Horn 2 Antennas

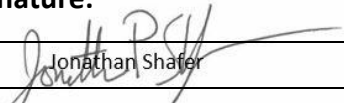
Equipment List:

Signal Hound BB60C USB Spectrum Analyzer
Signal Hound VSG60A RF Generator
Horn Antenna 1 - (ETS-Lindgren EID# 0744)
Horn Antenna 2 - (EMCO EID# 0930)

Additional Information:

- Photos of the antenna are provided in a separate exhibit: [GMN03002 Internal Photos](#)
- The Photos include a scale for dimensions

Signature:



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