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## Antenna Model: A206 RevA – Monopole

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# Contents

# 1 General Description

The monopole antenna used in the SR1020 evaluation kit has an omni-directional radiation pattern. This means that it radiates the electromagnetic waves uniformly in all directions around its axis. It has a linear (vertical) polarization and best performance is achieved when the Tx and Rx are aligned vertically with the antenna pointing upward.

The RF front-end consists of a differential feed line with two open stubs which improve the impedance matching and an antenna patch with a 5.9 GHz rejection notch filter as depicted in Fig. 1. This structure being a single ended circuit, requires a balun to connect to the SR1020 radio chip. The module is designed on a 2 layer FR4 PCB with a relative permittivity of 4.4 and a height of 0.8 mm.

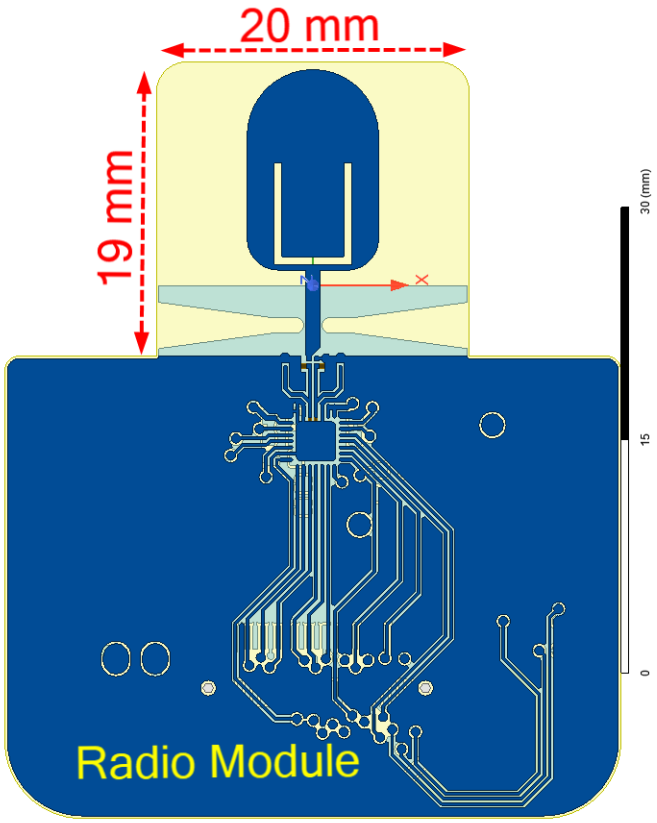


**Figure 1: Monopole antenna module.**

| Frequency(GHz) | 1 | 2.4 | 5.2 | 6 | 6.5 | 7 | 7.5 | 8 | 8.5 |
|---|---|---|---|---|---|---|---|---|---|
| Total Peak Gain(dBi) | -31.39 | -4 | -1.43 | -4.37 | 1.12 | 1.72 | 1.8 | 1.8 | 1.57 |
| Frequency(GHz) | 9 | 9.5 | 10 | 10.5 | 11 | 11.5 | 12 | 12.5 | 13 |
| Total Peak Gain(dBi) | 1.8 | 1.77 | 1.72 | 0.83 | -0.37 | -2.35 | -5.04 | -6.57 | -7.96 |

## 2 Simulated Performance

The simulated $S_{11}$ of the cascaded feed, balun (Anaren BD60120N50100AHF), and antenna is presented in Fig. 2. As it can be observed, the -10 dB impedance bandwidth is from 6.12 GHz to 9. 08 GHz covering all the required frequencies for the operation of the SR1020 radio. It should be noted that the RF front-end is matched with the output impedance of the PA in order to achieve minimum mismatch loss.

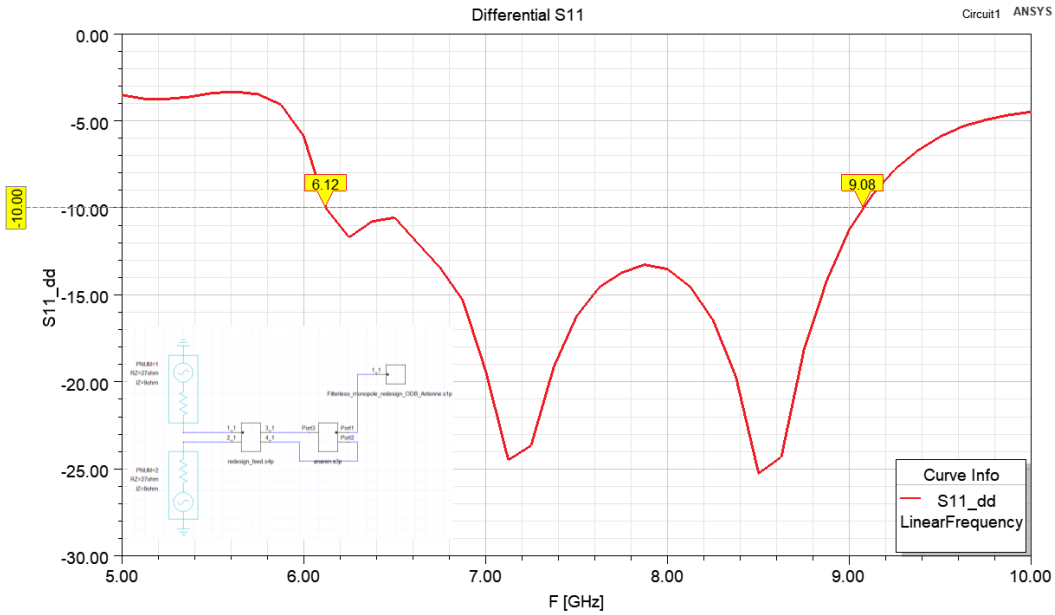


**Figure 2: Simulated $S_{11}$ result of the RF front-end.**

The radiation efficiency is obtained by calculating the ratio of radiated power over the incident power at the input of the antenna as depicted in Fig. 9. This is an accurate way of calculating the efficiency since it includes the impedance matching and insertion loss of the microstrip lines. The antenna peak realized gain is shown in Fig. 10 with a maximum of 2.7 dBi at 9 GHz. The feedline and balun losses of about 0.7-1 dB should be deducted in from this value to obtain the realized gain at the antenna output.

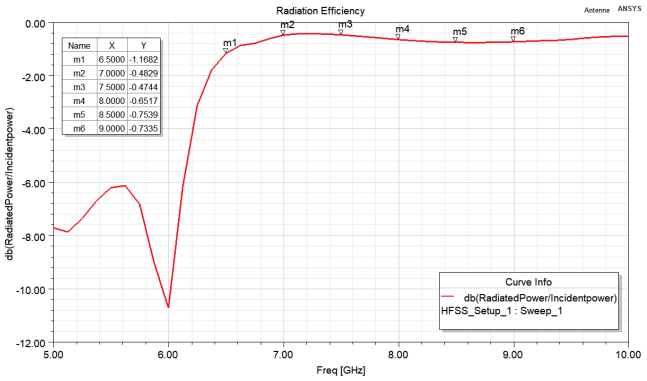


**Figure 3: Radiation efficiency of the RF front-end.**

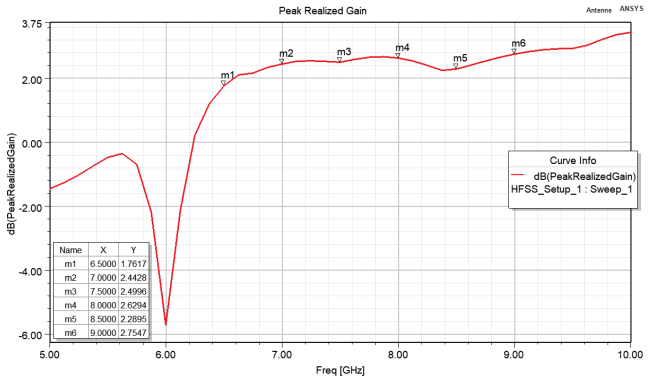


**Figure 4: Peak realized gain of the RF front-end..**

# 3 Simulated Radiation Patterns

The radiation pattern of the antenna is presented for the three main cuts of x-y, x-z, and y-z and for 6.5 to 8.5 GHz in Fig. 5-7. The 3D radiation pattern of this antenna at 7.5 GHz is also plotted in Fig. 8.

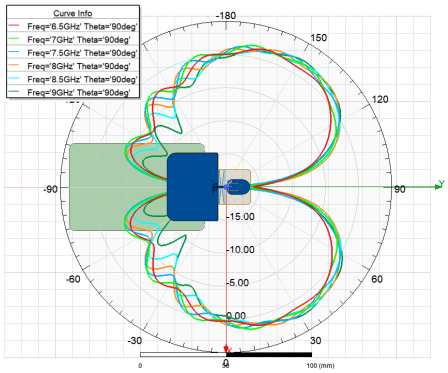


**Figure 5: Realized gain (dB) (xy-plane).**

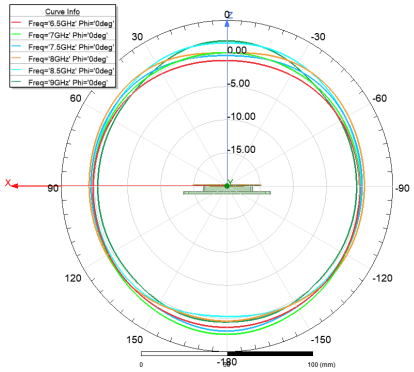


**Figure 6: Realized gain (dB) (xz-plane).**

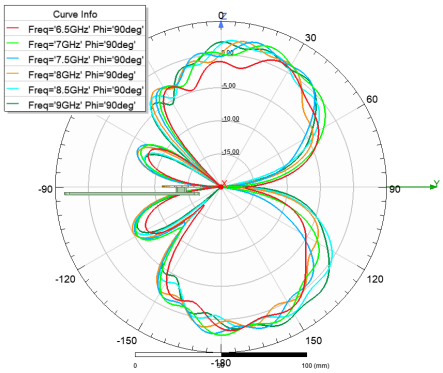


**Figure 7: Realized gain (dB) (yz-plane).**

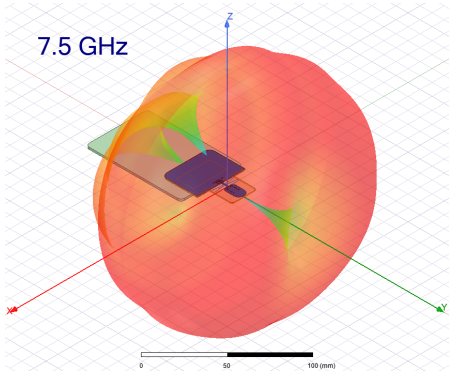


**Figure 8: 3D radiation pattern at 7.5 GHz.**

# 4 Dielectric Constant Variation

A dielectric constant variation analysis has been performed to visualize its effect on the antenna notch filter. As it can be seen, a variation of $\varepsilon_r$ = 4-4.8 causes about 0.5 dB variation in the losses and a frequency shift of 400 MHz in the notch filter resonant frequency.

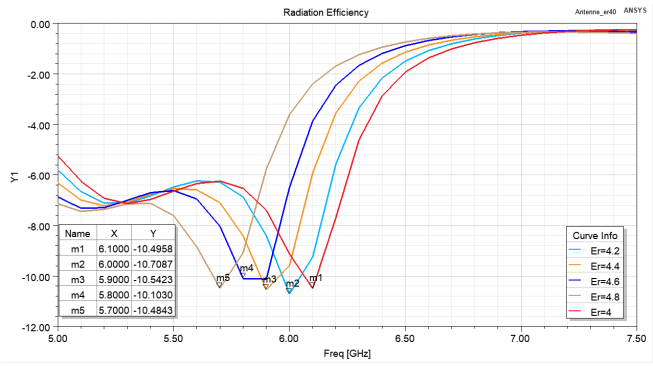


**Figure 9: Radiation efficiency of the RF front-end.**

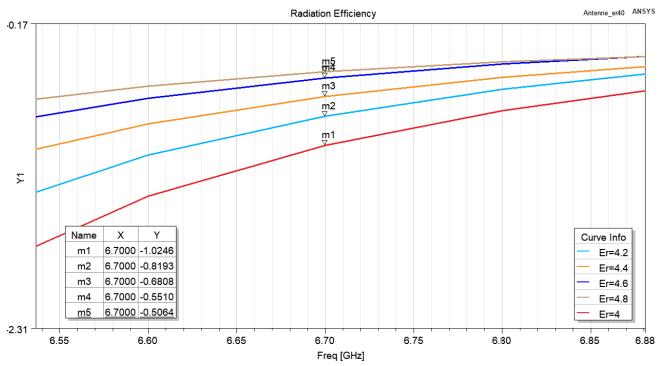


**Figure 10: Peak realized gain of the RF front-end..**