1 Introduction

As part of our project “Antenna Systems for Multiband Mobile & Portable Radio” [1], we developed a methodology for evaluation of LMR antennas over broad frequency ranges [2]. In the example shown in [2], and in subsequent analyses reported in [3], we reported receive sensitivity in terms of signal-to-noise ratio (SNR) achieved in response to a monochromatic “test” co-polarized electric field of 7.2 µV/m (RMS) applied at each frequency of interest. As explained in [2], this value was chosen because it yields SNR 6 dB above the SNR implied by the TIA-603-specified sensitivity criterion, assuming a quarter-wave monopole (QWM) operating at its nominal design frequency (453 MHz) and analog FM with 12.5 kHz bandwidth. While this is a reasonable approach, it has the disadvantage that the magnitude of the applied electric field is determined by the performance at the nominal design frequency of a specific, arbitrarily-chosen antenna; specifically, the 453 MHz-resonant QWM. While it is difficult to avoid an arbitrary choice of the antenna type, we would prefer to use a reference electric field magnitude that is not associated with an arbitrarily-determined frequency.

In this report, we propose that the electric field magnitude used in sensitivity calculations of the type shown [2] and [3] be determined not with respect to the 453 MHz-resonant QWM, but rather with respect to a QWM that is resonant at the frequency being considered. In this approach, the results do not depend on the arbitrarily-chosen design frequency of a reference antenna, and the results at frequencies far from the nominal design frequency of the antenna under test become a better indication of performance relative to a well-designed QWM operating at the frequency being considered.

Said differently, in this approach we are holding constant the open-circuit voltage at the antenna terminals (hence the power delivered to the load) of a frequency-varying reference antenna, as opposed to holding constant the magnitude of the incident electric field.

2 Determination of the Test Electric Field Magnitude

This modification is quite simple to derive. Recall that the open-circuit voltage at the antenna terminals in response to an electric field is the product of the electric field and the effective length. Also, the effective length of a monopole is linearly proportional to its length. Thus, the effective length of a QWM resonant at frequency $f_1$ is greater than the effective length of a QWM resonant at frequency $f_0$ by the ratio $f_0/f_1$. If we choose 7.2 µV/m for a QWM resonant at $f_0 = 453$ MHz, then the electric field which produces the same open-circuit voltage for a QWM resonant at $f_1$ must be $7.2f_1/f_0$ µV/m. Therefore the test electric field magnitude that we seek is:

$$\frac{4.8 \mu V}{\lambda},$$

(1)
where \( \lambda \) is wavelength. This is the electric field which results in the desired constant (same for each frequency) open-circuit voltage when applied to a QWM which is resonant at frequency \( c/\lambda \).

References

