1 Introduction

This report summarizes findings from Phase II of the project “Antenna Systems for Multiband Mobile & Portable Radio,” performed under Grant No. 2009-SQ-B9-K012 from the National Institute of Justice of the U.S. Dept. of Justice. The overall goal of this project is to develop and demonstrate land mobile radio (LMR) antenna systems which can operate in many frequency bands relevant to public safety operations in the United States. Our emphasis has been on vehicular multiband radio applications. This project is documented via the project web site [1] which includes an overview presentation [2]. Please refer to the latter (in particular, slides 1 and 2) for background on the motivation and specific goals of this project. A summary of the previous (Phase I) development effort is given in [3].

2 Summary of Phase II Outcomes

In Phase II of the project we designed, built, evaluated and field-tested a much-improved prototype antenna system, which now consists of a reconfigurable monopole-type antenna augmented with an improved electronic antenna tuner. Principal outcomes from Phase II, and the reports in which they are documented, are summarized below.¹

- Documentation of the “as built” Phase II design, including results of laboratory evaluation, appear in the following documents:

¹All cited project reports can be found at the project web site [1].
To summarize: We completed the design of the Phase II antenna system; demonstrated satisfactory operation in the VHF-Low, VHF-High, 220 MHz, UHF, and 800 MHz bands; and measured the limits of performance.

- Analysis and simulation leading to the design described in the above reports is documented in “Phase II Design for a Multiband LMR Antenna System” (S. Ellingson & R. Tillman, Project Report No. 18, August 30, 2011), and references therein.

- We rigorously documented and demonstrated our novel methodology for field evaluation of LMR antenna systems. The key element of this methodology is the use of in-band but subaudible “private line” (PL) tones in LMR signals to obtain a “bottom line” receive sensitivity metric for antenna systems in terms of audio signal-to-noise ratio. The methodology is documented in “Estimation of Pre-detection SNR of LMR Analog FM Signals Using PL Tone Analysis,” (A. Kumar & S. Ellingson, Project Report No. 16, May 2, 2012); see also [4, 5] for additional theoretical background.

- Field evaluation of the Phase II system, including analysis using the PL tone approach described above, is summarized in the following reports:

To summarize, we evaluated the Phase II system side-by-side commercial (reference) antenna systems in the VHF-High, UHF, and 800 MHz bands. We demonstrated in two separate field measurements (corresponding to the reports above) that the Phase II antenna system has performance which is comparable to or better than the commercial reference antenna in testing at 153 MHz and 453 MHz. At 851 MHz, the results were mixed. In Project Report 23, we found the performance was approximately the same; whereas in Project Report 25, we found the Phase II system was on average about 2.5 dB worse in audio SNR, which translates to approximately 1 dB worse in RF (“predetection”) SNR. We believe the shortfall at 851 MHz was either a poorly-optimized tuning solution, or possibly attributable to the 800 MHz-band insertion loss in the directional couplers used in the completed unit. In either case, we believe the performance at 851 MHz could reasonably be improved to a level comparable to that observed at 153 MHz and 453 MHz.

- We developed detailed wire-grid models suitable for analysis of monopole antennas on vehicles using the method of moments (in particular, the Numerical Electromagnetics Code (NEC)) for frequencies as high as 900 MHz. Models were developed for the Ford Crown Victoria and the Jeep Cherokee (XJ). Documentation of the models and the associated software are available via the project web site in reports [6] and [7].

Also, the following peer-reviewed papers stemming from efforts in this project were published during Phase II:


**Acknowledgments**

Virginia Tech personnel M. Harun, A. Kumar, R. Nealy, R. Tillman, and A. Schmitt contributed to the efforts described in this report.
References


