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Preliminary EMI testing of the Project54 police cruiser equipment

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Summary

The main goal of this facet of Project54 is to measure and analyze the electromagnetic interference (EMI) generated by the electronic components operating in the police cruiser. One of the major concerns in studying EMI is to ensure that the police radio is not jammed or degraded by locally-generated interference.

Any piece of equipment employing digital electronics will radiate electromagnetic energy to some extent. Whether or not that radiation will negatively impact another piece of electronic equipment depends upon the magnitude of the radiated signal, the location of the equipment, and frequencies at which the radiation occurs. The work reported here focuses on assessing the relative threat posed by the various electronic components in the cruiser. To accomplish this, radiation measurements were performed for all in-cruiser electronics using two approaches. The first was to measure radio emissions in close proximity to a component (near-field measurement), and the other was to record the signal delivered to the roof-mounted police-band radio antenna. The measurements reported here were collected using relatively low-cost equipment (under \$2000), and procedures and software are being developed so that these type of data can be collected by people without in-depth technical backgrounds.

The results of this preliminary study shows that many of the standard pieces of electronic equipment currently used inside police cruisers have the potential to interfere significantly with radio reception, particularly within fringe reception areas.

Measurement procedure

The first testing phase was performed in laboratory conditions (as opposed to being in a vehicle). The goal was to look for local “hot spots” (i.e., devices that have high electromagnetic fields in the near-field), which were detected using near-field probes. The probes used here are made by Laplace Corp., and are called ScanEM-C probes. The probes can detect the presence of either a local electric or magnetic field and provide audio and visual indication of its relative strength. These probes, which are pictured in Figure 1, can be used stand-alone, connected to a voltmeter, or in conjunction with a spectrum analyzer (the WiNRADiO served as the spectrum analyzer for these measurements, and it was used because of its portability and low cost).

In the first part of this study, all individual electronic components were probed to determine the highest near-field value emitted by that component, and those values are given in the Table 1 below to provide an indication of the relative threat potential for the components.



**Figure 1 Scan EM-C Probes
Used for Near-Field**

The values presented in Table 1 indicate the total signal energy radiated within the bandpass of the probes (≈ 100 KHz – 1 GHz), and they provide a reasonable indication of how well a component is shielded (importantly, they can be used to determine where the radiation is coming from, which indicates where additional shielding is needed).

Device	H-field probe		E-field probe		Comment
	LED level	mV (DC max)	LED level	mV (DC max)	
Light bar	1	0	5	1313	Synchronous with the strobe light
Light bar serial contr.	5	6.8	5	271.7	H-field probe positioned under 45° angle
Light bar control head	1	0	1	0.9	Slight signal from green to yellow near control wires
Common IDB interface	5	9.1	5	209.0	
Radar	1	0	5	34.1	Signal appears near LED display
Video unit	1		1		N/A ¹
Video display	1		5		N/A
Embedded PC	1	0	5	726	Signal appears near the coil
PC display	5	65.8	5	46.9	E-field signal appears on display itself H-field appears at upper left corner of the frame
Radio	1	0	1	0	
Microphone	1	0	1	0	

Table 1: Relative Near-Field Radiation Values

For this application, an important indication of threat potential is given by the spectrum of the radiation, particularly the spectrum within the police band. Figure 2 shows the spectrum of ambient noise collected by one of the near field probes. To collect the spectrum, the probe was positioned away from any local radiation sources; the significance signals seen in the plot are likely caused by local radio stations.

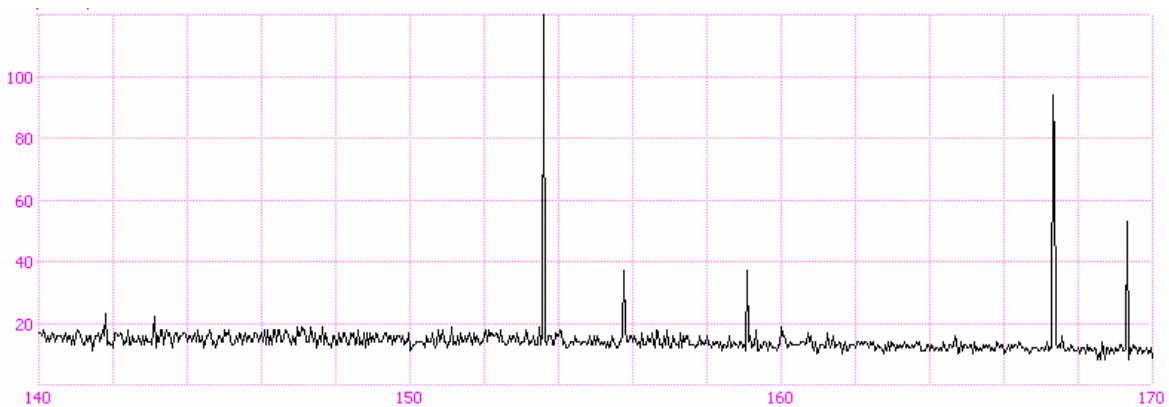


Figure 2: Spectrum of Ambient Noise from Near-Field Probe.

¹ The video unit was not available for spectrum measurements. Preliminary results showed that the video display is a significant source of radiation.

Figure 3 is a plot of the maximum-intensity signal spectrum that was obtained when the near field probe was positioned near to the high-intensity monitor.

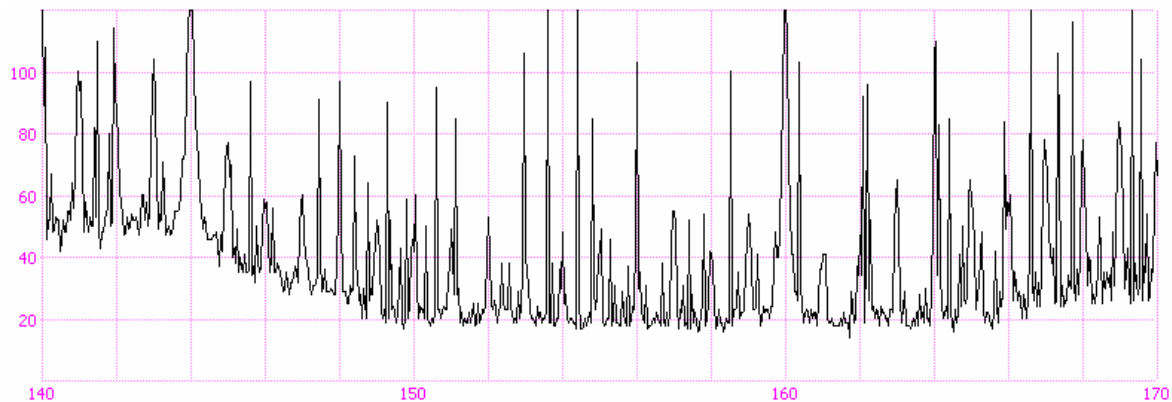


Figure 3 Frequency Spectrum with the Near-Field Probe Positioned Near the High-Intensity Monitor

The difference in signal levels between figures 2 and 3 represents the maximum interference generated by the high-intensity monitor. Because a significant amount of that energy falls within the pass-band of police radios, it has the potential to interfere with radio reception. Similar spectra were generated for other components within the cruiser, and they too generated interference within the police band.

While the near-field measurements presented above provide an indication as to whether a particular component might pose a threat to communication, the most important consideration is the amount of signal that gets into the police-band receiver. This was determined by connecting a spectrum analyzer to the roof-mounted police radio antenna, and then measuring the spectrum when the components within the cruiser were switched on and off. An example of this is seen in figure 4, where in this case the spectra are plotted when either all of the components in the cruiser are on or off. The ordinate of the plot is in decibels.

Referring to figure 4, it is seen that a very large amount of interfering signal (given by the difference between the red and blue plots) is introduced within the range of police-band frequencies. The significance of this is that unless the desired received signal is strong, the interfering signal could prevent that signal from being received. Similar data were collected as individual components recycled on and off, and all showed, to some degree at least, the capability to interfere with radio reception.

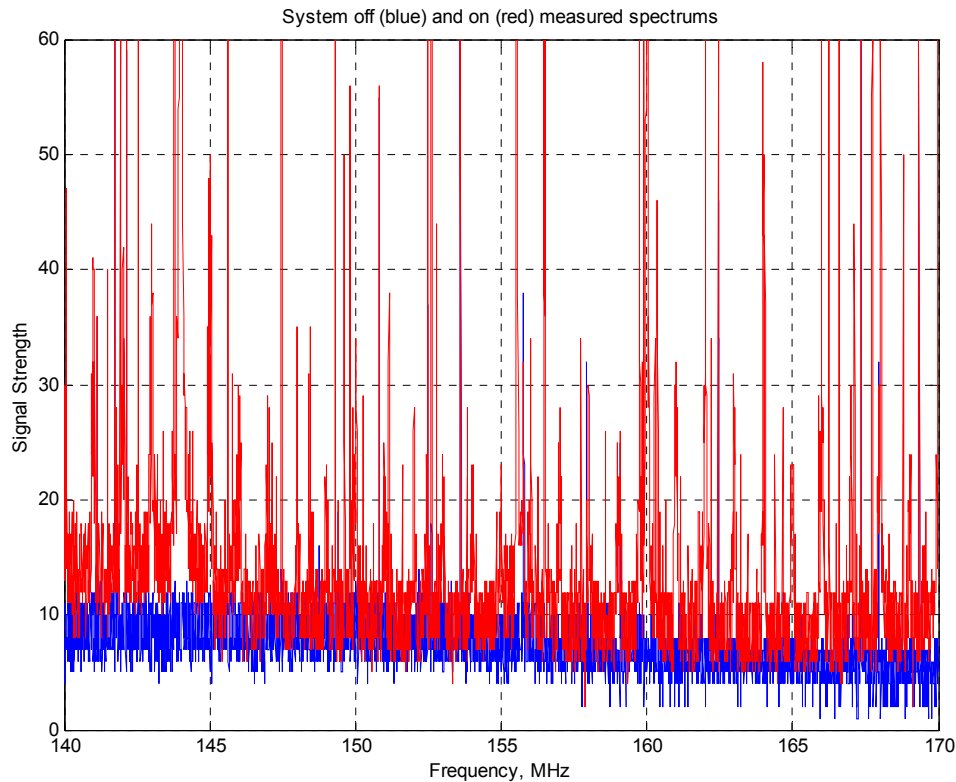


Figure 4 Spectra of Signals Delivered by the Roof-Mounted Antenna Both with the In-Cruiser Electronics Turned Off (blue) and Turned On (red)

Future work

The results of the preliminary data collection effort described here show that interference from in-cruiser electronics does pose a major threat to radio reception. Consequently, future work will be targeted at approaches to minimizing or eliminating that interference. Efforts are currently underway to implement additional shielding on the IDB data bus and its associated components. Further, the manufacturers of other equipment found to pose an EMI threat will be provided with detailed radiation information about their product as determined by this study. UNH will work with these vendors to identify and implement shielding solutions, and to validate that those solutions are effective.

In the longer-term, test procedures will be established, and equipment will be identified that will enable equipment installers to assess and troubleshoot interference problems.