The Visualization of EMC

GARY GUNTHORPE
Emscan Corporation

INTRODUCTION

The advent of near-field antenna scanner arrays has provided the printed circuit pack (PCP) designer/tester with a hitherto unavailable ability to visualize electromagnetic performance. Multi-probe electromagnetic scanning of PCPs transforms electromagnetic signals into visual displays which indicate signal strength relative to frequency (spectral) and position (spatial) on the PCP. Visual displays provide images of a board's electromagnetic performance, thereby facilitating design improvements and/or assisting in troubleshooting efforts.

Scanner arrays provide a lens into the unseen world of EMC. The use of such a lens allows better product design, significantly reduces pre-compliance times, with consequent reductions in time-to-market cycles; reduces re-engineering or modification costs; effectively ensures ongoing EMC compliance with pre-set standards; and minimizes life-cycle costs. Also, under certain conditions, the multi-probe scanning systems may provide low-cost, automated, non-contacting testing of PCP EMC quality and performance on the manufacturing line.

What the designer can't see in the EMC world affects the commercial viability of a product.

SCANNING TECHNOLOGY

The strength of scanner arrays lies in providing data to define the level, shape and location of noise sources on PCPs and cabling. This knowledge is of significant assistance to the designer in reducing the level of emissions. A scanning array system is available that consists of an 8-layer printed circuit board, onto which 1280 small loop antennas are printed in a 32 x 40 matrix (Figure 1). Each antenna is addressed individually, and can be turned on, one at a time.

These antennas are designed to accurately measure the level of the H field adjacent to them and can be thought of as simple single-turn transformers (Figure 2). The designer places the operating circuit board to be tested close to the scanning array's scanning surface. The software steps through a selected area of the antenna, measuring the currents flowing on the board under test.

A computer provides overall control over both the antenna selection and the spectrum measuring instrument (either an analyzer or receiver). The computer also handles data manipulation, storage, retrieval and display.

A spectrum analyzer or receiver is used to measure the level of the signal on the selected antenna. Two basic types of scans can be performed: spectral and spatial. Measurements can be taken across a wide span of frequencies (spectral) or measured at one frequency, while the antenna is stepped over a measurement area (spatial).

SPECTRAL SCANS

A spectral scan provides a plot of the peak emission levels against frequency as measured from a selected sample of antennas (Figure 3). This plot is similar to that displayed by spectrum analyzers. Such a scan allows the designer to identify and select frequencies of interest for further analysis and to evaluate the harmonic content of the currents flowing on the PCP.

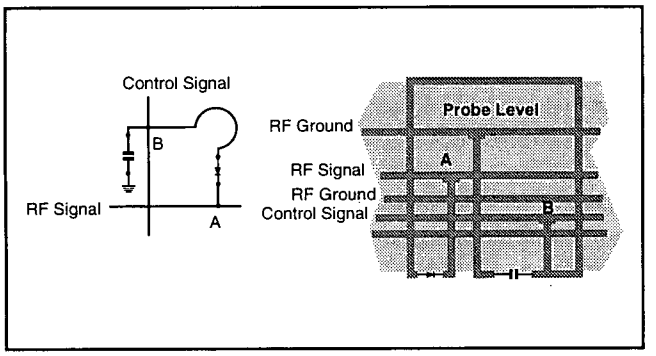

***Figure 1**. Loop Antenna.*

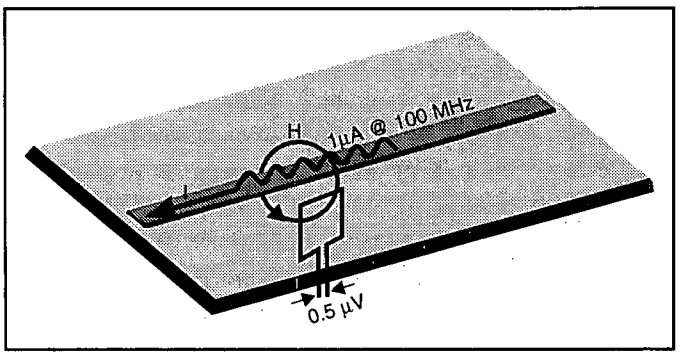

***Figure 2**. Single Loop Transformer.*

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SPATIAL SCANS

Having selected the frequencies of interest, the designer can then investigate emissions from the PCB. By mapping both the path and intensity of every high frequency current flowing on the PCB, sources of emissions are defined. This is called a spatial scan (Figure 4).

A spatial scan provides the designer with an "electromagnetic signature," or color topographic map of the near H-field emission intensities from the PCP under test, at the designated frequency. Spatial scans give the designer visual images of the RF currents flowing on the PCP and clearly identify high noise level areas.

Spatial scans of different boards, or the same board under different conditions, can be compared to show differences in the emission levels and current flow patterns. Component/track location overlays can be used to better correlate areas of high emissions with component and circuit location.

Spatial scans are particularly helpful to the PCP designer in that they aid and expedite assessment of a board's electromagnetic performance at an early stage of the development schedule, a point where remedial actions are relatively easy and inexpensively implemented. Other common uses of spatial scans include troubleshooting established PCP designs, assessment of the EMC impact of component substitution and/or evolutionary product modifications, and ongoing compliance audits.

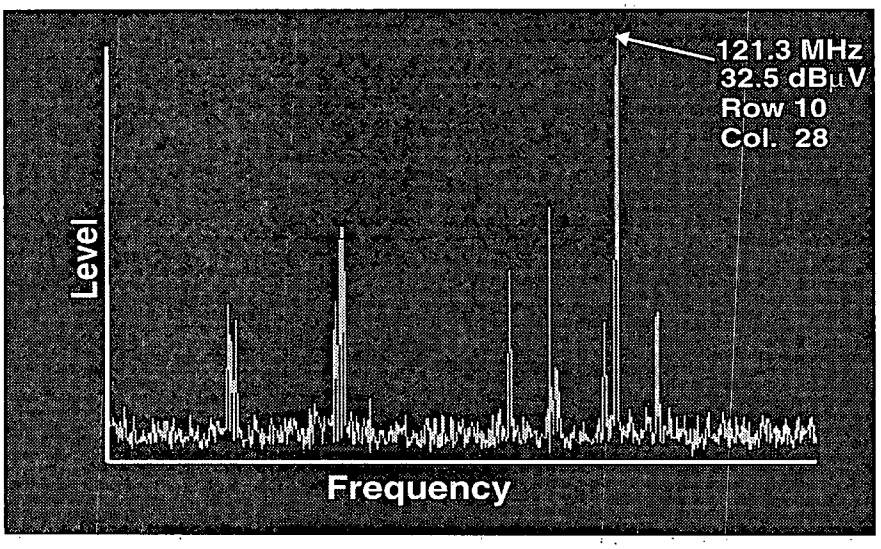

Figure 3. *Spectral Display.*

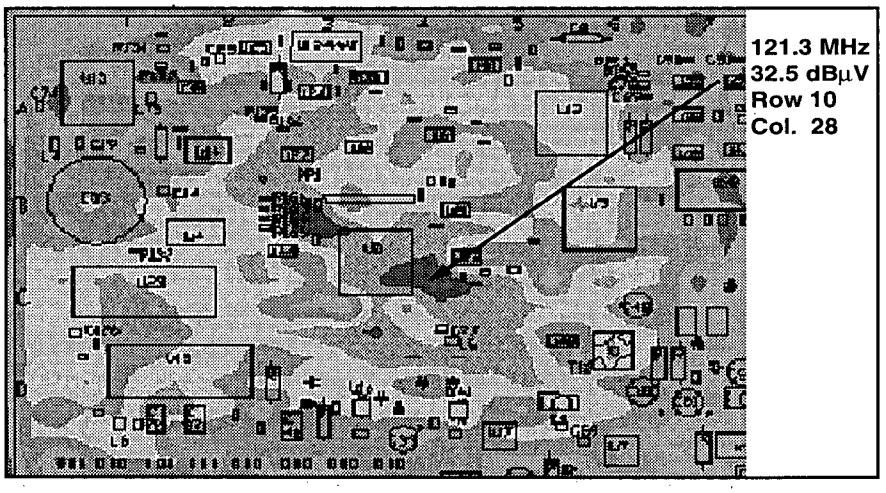

Figure 4. *Spatial Display.*

CONCLUSION

Over the past five years, the approach of visualizing EMC using a near-field probe array has gained increasing acceptance. Many of the world's leading electronics manufacturers are making active use of these near-field scanner systems in their PCP design and testing activities, and many of these companies are multiunity users. The ability of the user to "see" electromagnetic performance at the board level is one of the most attractive features of these scanning systems, which quickly focus on unwanted noise sources, often helping the user to identify probable causes.

Visualization is the key to better understanding a PCP's electromagnetic performance. This understanding has been exponentially expanded by the fast, multiple perspectives provided by scanning systems. In the near future, the surge of new visualization capabilities will be further augmented by very high speed spectral/spatial data gathering, enhanced comparison and manipulation capablities, and time-based scanning. As these faster systems become available, the user will be able to instantly access and review the complete spectral and spatial scans of a PCP, and scanning systems will be used on production lines to test for EMC on-line.

Visualization, both in terms of visual displays and the mental explorations of the EMC practitioners, will continue to be the driving force behind the use of near-field scanning.

GARY E. GUNTHORPE *graduated from the University of Manitoba, Canada, in 1972. His early career involved designing instruments for industrial applications. He served as president of the Electronics Industry Association of Alberta for two years. Since joining Emscan Corporation in 1989, as Director of Engineering, he has been responsible for developing new EM scanning technologies. (403) 291-0313.*