1–50-MHz VHF EMI Instrumentation Sensor Circuit

Orlando Lazaro, *Student Member, IEEE*, Gabriel A. Rincón-Mora, *Senior Member, IEEE,* and Justin Vogt, *Student Member, IEEE*

Georgia Tech Analog, Power, and Energy IC Research Lab
Orlando.Lazaro@ece.gatech.edu, Rincon-mora@ece.gatech.edu, and JVogt@ece.gatech.edu
777 Atlantic Drive NW • Atlanta, GA 30332-0250 • 404.385.2768

With telecommunication networks connecting wireless devices around the globe, there is a growing abundance of electromagnetic signals that produce considerable electromagnetic interference (EMI) across the air waves. These communication networks are dynamic and produce position- and time-varying electromagnetic fields that cannot be easily predetermined or predicted. Unfortunately, high-performance electronics are especially sensitive to EMI, for which shielding is often a necessity. Measuring the power attenuation across a shielded barrier before, during, and after deployment, to ensure system integrity, is therefore critical. To this end, an EMI instrumentation circuit is proposed that combines the complementary attributes of contemporary solutions such as thermal[1], capacitive, and peak-signal detection[2] schemes.

As shown in Figure 1a, the proposed sensor compares the power difference between source signal v_s and attenuated signal v_a. Both inputs follow similar signal-flow paths, starting with low-noise amplifier A_{LNA} to (1) decrease the overall noise figure of the circuit and (2) amplify the signals for the rectification process. The half-wave rectifier then produces a series of unipolar pulses that the low-pass filter (LPF) processes by eliminating the corresponding ac components, leaving only steady dc signals that are proportional to the signal strengths present at v_s and v_a.

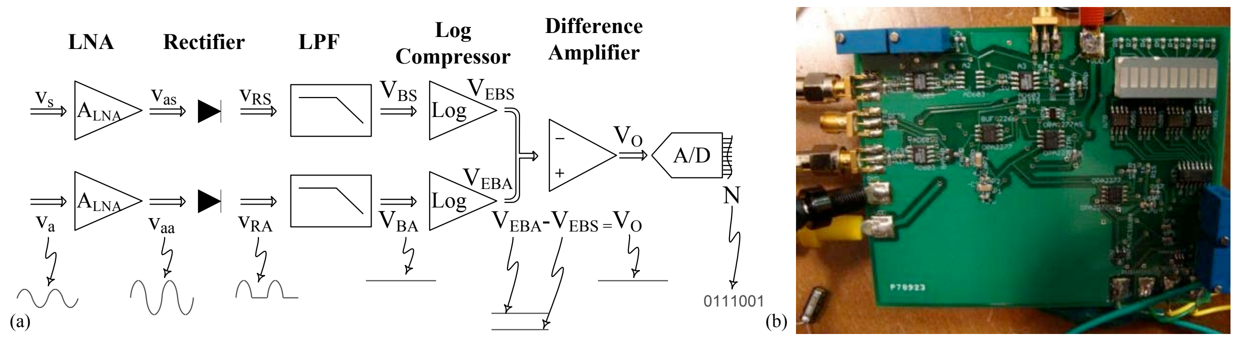

Fig. 1. (a) Block diagram and signal progression of proposed EMI sensor and (b) the corresponding printed-circuit-board prototype.

Logarithmic amplifiers then logarithmically compress the resulting dc signals so that their difference, as achieved by the difference amplifier, is actually the ratio of the relative signal strengths of v_s and v_a, which in logarithmic form, represents the decibel power difference between the source signal and its attenuated counterpart:

$$V_O \cong \left\{\left(\frac{kT_Q}{q}\right)\left[\frac{R_{DF}\ln(10)}{20R_D}\right]\right\}10\log\left(\frac{v_{s(Peak)}}{v_{a(Peak)}}\right)^2 = \beta\left(P_{s.dB} - P_{a.dB}\right). \tag{1}$$

Output voltage V_O is then proportional to the power attenuation across a shielded enclosure, which describes the degree of EMI shielding[3] achieved across the enclosure. Output signal V_O is analog in nature so an analog-digital (A/D) converter is cascaded to generate a digital signal that a reader can decode and decipher.

A printed-circuit-board (PCB) implementation of the proposed EMI instrumentation circuit is presented, as shown in Figure 1b, and tested at 1 – 50 MHz. The sensor is accurate to within 5 bits with a dynamic range of 16 dB across the stated frequency range. Temperature compensation and diode-induced error-correction circuitry were incorporated into the prototype to increase its overall accuracy. A tradeoff between dynamic range and accuracy is noted and calibrated to accommodate the bit error. In all, the proposed EMI sensor was designed, built, and tested and the resulting prototype achieved its stated objectives of measuring EMI across 1 – 50 MHz.

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[1] J. C. Cowles, "The Evolution of Integrated RF Power Measurement and Control," *IEEE Mediterranean Electrotechnical Conference*, pp. 131-134, 2004.

[2] R. G. Meyer, "Low-Power Monolithic RF Peak Detector Analysis," *IEEE Journal Of Solid-State Circuits*, Vol. 30, No. 1 pp. 65-67, 1995.

[3] *ASTM Standards*: E 1851 Test Method for Electromagnetic Shielding Effectiveness of Durable Rigid Wall Relocatable Structures.