A FREQUENCY TRACKING, TUNED, RECEIVING MONOPOLE

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Various active antennas have been utilized for receiving purposes in the low to medium high frequency region because of their advantage of high sensitivity for a given size. They have certain drawbacks however, such as limited dynamic range and intermodulation distortion. While no technical approach is satisfactory for all purposes, the antenna described in this paper was designed for weak short wave signal reception in the presence of very large out-of-band signals, e.g., commercial broadcast stations.

The antenna proper consists of a 2.5 meter collapsible monopole (whip) which is resonated with an inductance, and a pair of matched voltage variable capacitive diodes, to the frequency of interest. The signal at the base of the antenna is then applied to a V-MOS power FET follower circuit with negative feedback yielding an output at a 50 Ω impedance. Octave bands can be tuned with the voltage variable capacitive diodes and are set to match the bands of a typical field intensity meter (FIM). Operating bandwidths vary from approximately 10 kHz at 250 kHz to 1 MHz at 30 MHz.

Referring to figure 1, a simplified block diagram, we see that the tuning of the antenna is controlled by the FIM. An output voltage available at the rear of the FIM is proportional to the frequency to which it is tuned. This voltage is digitized in an A/D converter and used as the address for a ROM lookup table. The output of the ROM memory goes to a D/A converter and tunes the variable capacitive diode circuit to the proper frequency. A front panel control allows manual tuning if desired. Band switching signals, also available from the FIM, activate reed relays to switch the resonating inductors in the antenna circuit. Broadband untuned operation of the antenna is also available when desired, or to be used below 250 kHz, which is the lowest octave band available in the FIM being used. A 20 dB capacitive divider switchable attenuator allows signals of up to 1 volt/meter to be handled in the untuned configuration with intermodulation products > 80 dB below signal level. The data shown in the following figures however is with the attenuator in the zero dB position.

Figure 2 shows the response of the antenna in terms of antenna factor (AF) which is:

$$AF = 20\log_{10} \frac{E\ \text{field}}{V\ \text{out}} .$$

There are several ways to represent the sensitivity of antennas, not all of which are equally meaningful to the person making field intensity measurements. In figure 3 the noise floor of the antenna is plotted in terms of the equivalent RMS field strength in dB μ volts/meter which that noise represents. Also plotted on the same curve is the quasi-minimum atmospheric background noise level (ECAC-CR-76-074 October 1976) which is useful in gauging the ability to measure background noise levels in typical locations.

Figure 4 shows second and third order intermodulation responses versus signal level for interfering signals located within the octave below the frequencies being tuned. Figures 5 and 6 show the dramatic improvement in spectrum analyzer performance using this antenna in the tuned mode. In figure 5 the antenna is operating in the broadband configuration with the resulting large number of distortion products, many generated within the spectrum analyzer itself. Figure 6 shows the 4 - 8 MHz frequency band tracked with the spectrum analyzer in this range.

The antenna is mounted on a small aluminum enclosure which connects to a control/interface unit. The ROM lookup table and analog conditioning circuits are located on a plug-in personality card so the tuning function can be adapted to other FIMs. Internal batteries allow for portable operation. For more versatility an IEEE 488 bus interface is being contemplated.

It is felt that this antenna combines flexible performance with enhanced sensitivity accompanied by low distortion products, in the tuned mode of operation.

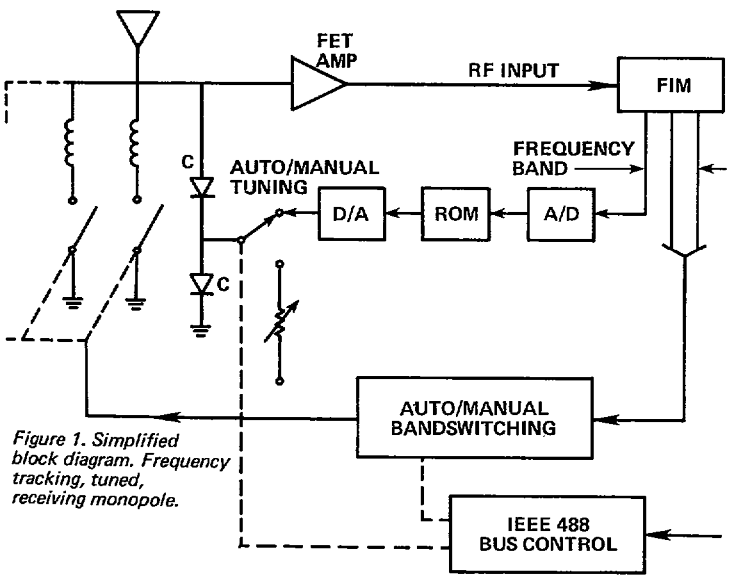

Figure 1. Simplified block diagram. Frequency tracking, tuned, receiving monopole.

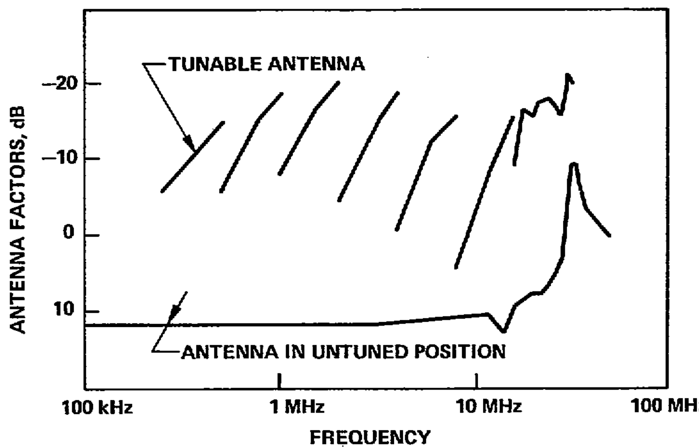

Figure 2. Antenna factors.

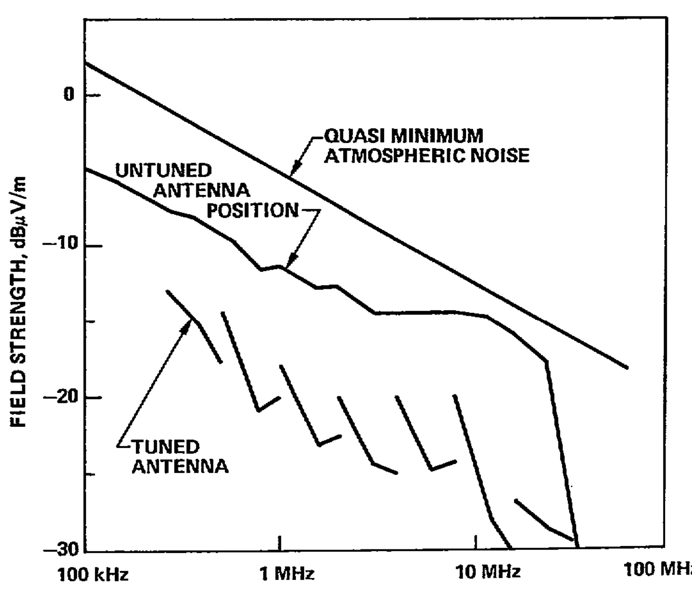

Figure 3. Sensitivity (noise floor) of antenna.

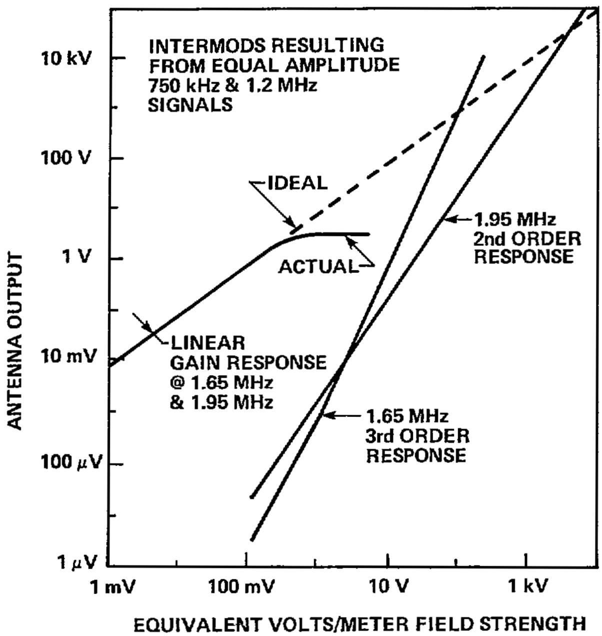

Figure 4. Intermodulation of tuned antenna.

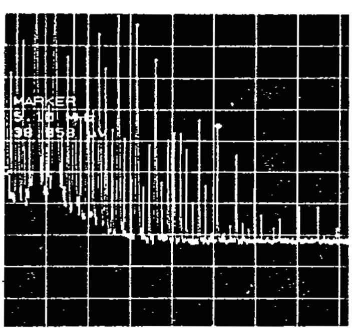

Figure 5. Antenna in broadband configuration. 0-8 MHz spectrum analyzer sweep. 10 dB/vertical division. Interfering signals 1 V/meter at 750 and 1200 KHz. Marker dot amplitude at center is equivalent to 435 µV/m.

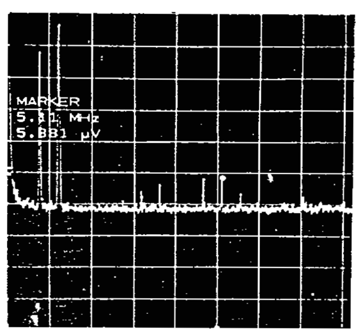

Figure 6. Antenna tuned and tracked to spectrum analyzer over 4-8 MHz range. Other conditions same as figure 5. Marker dot amplitude at center screen is equivalent to 8.3 µV/m.