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- (54) **DIELECTRIC CONSTANT MEASUREMENT CIRCUIT AND DIELECTRIC CONSTANT MEASUREMENT METHOD**
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- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
2012/0150000 A1 6/2012 Al-Shamma'a et al.
- FOREIGN PATENT DOCUMENTS
TW 1320150 B 2/2010
- OTHER PUBLICATIONS
V. Sekar et al., "A Self-Sustained Microwave System for Dielectric-Constant Measurement of Lossy Organic Liquids," in IEEE Transactions on Microwave Theory and Techniques, vol. 60, No. 5, pp. 1444-1455, May 2012.
A. Helmy et al., "A 1-8-GHz Miniaturized Spectroscopy System for Permittivity Detection and Mixture Characterization of Organic Chemicals," in IEEE Transactions on Microwave Theory and Techniques, vol. 60, No. 12, pp. 4157-4170, Dec. 2012.
A. A. Helmy et al., "A Self-Sustained CMOS Microwave Chemical Sensor Using a Frequency Synthesizer," in IEEE Journal of Solid-State Circuits, vol. 47, No. 10, pp. 2467-2483, Oct. 2012.
F.-C. Chang et al., "A Novel design of Antenna for biosensing applications," 14th International Meeting on Chemical Sensors(IMCS 2012), May 20-23, 2012.

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(57) **ABSTRACT**

- (30) **Foreign Application Priority Data**
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A dielectric constant measurement circuit includes a dielectric constant sensor, an oscillator controlling circuit, a waveform converting circuit, and a counting readout circuit. The oscillator controlling circuit generates an oscillation waveform according to the response of the dielectric constant sensor to a dielectric material. The waveform converting circuit converts the oscillation waveform into frequency division square waves. The counting readout circuit includes a switching counter, a switching circuit, a reference current source, and a current integrator. The reference current source charges the current integrator through the switching circuit controlled by the frequency division square waves, and the switching counter counts the number of the turned-on states of the switching circuit and stops counting the number of the turned-on states when a value of the output voltage from the current integrator reaches a value of the reference voltage, and the number of the turned-on states is related to the oscillation frequency.

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- (58) **Field of Classification Search**
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