ABSTRACT

A PLL-Based Frequency Shift Measurement System for Chemical and Biological Sensing

(December 2011)

William Torke

Chair of Advisory Committee: Samuel Palermo

A PLL-based frequency shift measurement system for chemical and biological sensing was developed and implemented in the form of two discrete electronic assemblies. One of the assemblies consists of a VCO which contains a microwave resonator sensor while the other assembly contains commercially available PLL and MCU devices, as well as various other discrete components. When mated together, a PLL-based frequency synthesizer is realized, the output frequency of which is ~4.5 GHz. The system is used to measure the frequency shift exhibited by the frequency synthesizer when several commonly-known chemical substances are applied to the microwave resonator sensor test fixture. Because the amount of measured frequency shift is proportional to the dielectric constant of a given material under test (MUT), this system can potentially be used as part of a chemical identification system. This measurement system is also attractive in that it represents a stand-alone or 'self-contained' system which does not require usage of any additional expensive and bulky electronic diagnostic equipment such as a network analyzer or signal generator, making it a relatively inexpensive and portable solution. Attempts to use the system to measure frequency shift resulting from application of various common chemical substances to the sensor fixture results in derivation of dielectric constant values which hold very close agreement (+/-2%) to the published/theoretical dielectric constant values for each respective chemical substance.