Abstracts

Cryogenically cooled sapphire-rutile dielectric resonators for ultrahigh-frequency stable oscillators for terrestrial and space applications [atomic frequency standards]

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The highest short-term frequency-stable microwave resonator oscillators utilize liquid-helium-cooled sapphire dielectric resonators. The temperature coefficient of frequency of such resonators is very small due to residual paramagnetic impurities canceling the temperature coefficient of permittivity (TCP). At high temperatures, which are accessible in space or with liquid nitrogen, the effect is too weak, and if extra impurities are added, the loss introduced is too great. An alternative technique involves using two low-toss dielectric materials with TCP of opposite sign. Following this approach, a sapphire-rutile resonator was designed with mode frequency-temperature turning points between 50-80 K, with Q-factors of order 10/sup 7/. Previous designs used thin disks of rutile fixed to the ends of the sapphire cylinder. Due to the high permittivity of rutile, such resonators have a high density of spurious modes. By placing rings at the end faces instead of disks, the majority of the spurious modes are raised above the operation frequency and the requirement for thin disks is removed. Finite-element analysis has been applied and compares well with experiment. The application to the design of high stability "fly-wheel"oscillators for atomic frequency standards is discussed.

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