A TWO-COLOR FOURIER TRANSFORM MM-WAVE SPECTROMETER FOR GAS ANALYSIS OPERATING FROM 260-295 GHZ

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We have designed a two-color mm-wave spectrometer for Fourier transform mm-wave spectroscopy that uses consumer level components for the tunable synthesizers, digital control of the pulse modulators, and digitization of the coherent free induction decay (FID). The excitation pulses are generated using an x24 active multiplier chain (AMC) that produces a peak power of 30 mW. The microwave input to the AMC is generated in a frequency up conversion circuit that accepts a microwave input frequency from about 2-4 GHz. This circuit also generates the input to the mm-wave subhamonic mixer that creates the local oscillator from a separate 2-4 GHz microwave input. Excitation pulses at two independently tunable frequencies are generated using a dual-channel source based on a low-cost, wideband synthesizer integrated circuit (Valon Technology Model 5008). The outputs of the synthesizer are pulse modulated using a PIN diode switch that is driven using the arbitrary waveform generator (AWG) output of a USB-controlled high-speed digitizer / arbitrary waveform generator combination unit (Tie Pie HS-5 530 XM). The two pulses are combined using a Wilkinson power divider before input to the up conversion circuit. The FID frequency is down converted in a two-stage mixing process to 65 MHz. The two LO frequencies used in the receiver are provided by a second Valon 5008. The FID is digitized at 200 MSamples/s using the 12-bit Tie Pie digitizer. The digital oscilloscope (and its AWG channel) and the two synthesizers use a 10 MHz reference signal from a Rubidium clock to permit time-domain signal averaging. A key feature of the digital oscilloscope is its deep memory of 32 Mpts (complemented by the 64 Mpt memory in the 240 MS/s AWG). This makes it possible to perform several one- and two-color coherent measurements, including pulse echoes and double-resonance spectroscopy, in a single readout experiment to speed the analysis of mm-wave rotational spectra. The spectrometer sensitivity and frequency accuracy are illustrated by high-speed measurements of OCS rotational transitions for low-abundance isotopes. Examples of pulse echo measurements to determine the collisional relaxation rate and two-color double-resonance measurements to confirm the presence of a molecular species will be illustrated using OCS as the room-temperature gas sample.