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WWV Time and Frequency Broadcasts

With this issue's special product focus on oscillators, it seems like a good time for some notes on the readily-available precision time and frequency broadcasts of WWV and WWVH.

History

WWV began broadcasting in 1920, as a research transmitting station of the National Bureau of Standards (now the National Institute of Standards and Technology). Its first broadcasts were music concerts, both for entertainment of listeners in the local Washington, DC area, and for testing of various radio apparatus.

In January 1923, WWV began the broadcast of standard frequency signals. By May of that year, frequencies of 75 to 2000 kHz were broadcast, with an accuracy quoted as being better than 0.3%. In January 2007, WWV will have provided standard frequency services for 84 years!

Quartz crystal oscillators were first used at WWV in 1927, and by 1932, the frequency was controlled to less than 2 parts in 10^7. By 1935, the station was broadcasting on the familiar 5, 10 and 15 MHz frequencies. 2.5, 20, 25, 30 and 35 MHz transmissions were added in 1944-46, with 25 and 30 MHz ended in 1953 and 25 MHz discontinued in 1977.

Telegraphic code announcements were added in 1945, and voice announcements started in 1950. Today, voice messages and coded data offer a number of special services for those who monitor the station (Table 1). The present WWV transmitter location in Ft. Collins, Colorado began operation 40 years ago, on December 1, 1966.

With service beginning in 1948, WWVH provides additional broadcast coverage from its transmitting site on the island of Kauai in Hawaii. Currently, WWVH transmits on 2.5, 5, 10 and 15 MHz. The 2.5 MHz antenna is omnidirectional, but the three higher frequencies use antenna systems with broad cardioid patterns beamed toward the west.

In the late 1950s, WWV played a significant role in the development of the atomic clock. Researchers at the US Naval Observatory (USNO) and at the UK's National Physical Laboratory (NPL) would simultaneously monitor WWV and compare the new cesium standard developed at NPL with the astronomical time maintained by the USNO. That work defined the second as the duration of 9,192,631,770 cycles of the cesium atom oscillation.

Standard radio frequencies:	2.5, 5, 10, 15, *20 MHz
Standard audio frequencies:	440 Hz (musical A above Middle C), 500 Hz, 600 Hz
Time intervals:	Second, 10 seconds, minutes, hours
Time signals (voice):	Once per minute
Time intervals (code):	BCD code on 100 Hz subcarrier, 1 pulse/s
Official announcements:	Geoalerts (solar flux, K index, A index, space weather), Marine storm warnings, GPS status reports

**WWVH does not transmit on 20 MHz*

Table 1 · Information provided via WWV and WWVH broadcasts.

Transmission Accuracy

When the Ft. Collins site was activated, the proximity to atomic oscillators in the NBS Boulder laboratories made it possible to maintain transmitted frequency accuracy of 2 parts in 10^{11}. Today, the accuracy is within a few parts in 10^{13}.

Although many precision references now use Global Position System satellite transmissions instead of WWV broadcasts, the radio service remains popular and useful. For example, a simple shortwave receiver and a good ear are all that is needed to evaluate the accuracy of a common 10 MHz frequency reference. A sample of the oscillator output is provided to the receiver at nearly equal amplitude to the WWV signal. The the difference in their frequencies (the "beat note") is readily detectable by ear to better than 0.1 Hz difference (1×10^{-8} at 10 MHz), and can be monitored on an oscilloscope or chart recorder if less.

In addition to the official services contained in the broadcasts, the wide spread of transmitting frequencies in the HF portion of the spectrum provides a known, continuous series of beacons that can be used to evaluate propagation. Long-range shortwave propagation also allows students, researchers and companies around the world to have access to the precision of NIST's time and frequency standards.

References

1. NIST Special Publication 432, "NIST Time and Frequency Services," 2002, available at http://tf.nist.gov/timefreq/general/pdf/1383.pdf
2. NIST home page: http://www.nist.gov/