

The Heartbeat of the Shortwaves

Shortwave station WWV has operated for over a century, and has broadcast precise time and frequency information for more than 50 years.

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Every night, over 50 million devices in the US receive a signal containing time codes through their internal antennas and receivers, which then interpret the codes to ensure near-perfect synchronization. That signal has been coming from WWV in Fort Collins, Colorado, for over half a century.

Among many other things, the National Institute of Standards and Technology (NIST; www.nist.gov) is responsible for the maintenance and operation of shortwave stations WWV, WWVB, and WWVH (in Hawaii) through its Time and Frequency Division. Shortwave enthusiast Thomas Witherspoon, K4SWL, called WWV “the heartbeat of the shortwaves.” He explained, “The NIST reference signals are ever-present and easily accessible here in North America and other parts of the world.”

Vintage Technology

Since 1965, WWV and its companion station, WWVB (often collectively referred to as “WWV”), have broadcast Coordinated Universal Time (UTC) to the exact second to the continental US. WWV is the oldest con-

tinuously active radio station in the country (see the sidebar, “The History of WWV”). WWVH, its Hawaiian counterpart, broadcasts the same information for the island state. Using long electromagnetic waves at 60 kHz — a frequency so low it can be received through buildings — WWVB’s signal allows millions of timekeeping devices across the country to sync, usually in the middle of the night, when the signal is strongest. These devices contain small, internal antennas and receivers, which interpret the time codes sent by WWVB to maintain accurate readings of the time and the day of the year, as well as adjust for daylight saving time and leap years.

WWVB signals reach all these devices via the 60 kHz longwave band, but WWV and WWVH signals leverage the shortwave bands. There’s no official definition of the “shortwave band,” but it generally extends from the high end of the medium-frequency (MF) band to the end of the high-frequency (HF) band. Radio waves in the shortwave band are reflected off the ionosphere, which means they can be directed at certain angles that allow them to travel long distances, unlike some radio waves that use line-of-sight propagation and travel in straight



An aerial view of WWV. The station broadcasts six frequencies with their own antennas, which are all surrounded by a white fence. The lowest frequency has the tallest antenna, and it requires a flashing strobe to be visible to passing aircraft.

The History of WWV

1919: NIST (then called the National Bureau of Standards) was assigned the call letters “WWV.”

1920: The Bureau started testing the station, broadcasting musical concerts on Friday nights, and later broadcasting market news for the Department of Agriculture.

1922: It was decided that the station would transmit standard frequency signals.

1927: WWV started using quartz oscillators to improve the station’s output frequency.

1932: The station moved to a Department of Agriculture site near Beltsville, Maryland, where it began broadcasting on 5, 10, and 15 MHz, which it continues to use today.

1936: Musical organizations suggested WWV add the 440 Hz tone (A above middle C), for the sake of tuning instruments.

1940: WWV was destroyed by a fire, but returned to the air in a nearby building 5 days later, using equipment salvaged from the burned station.

1943: A newly built station went on the air.

1944: WWV added the 2.5 MHz frequency as a way of reaching the nearby population. Over the years, the 20, 25, 30, and 35 MHz frequencies were also added to the station’s broadcasts, but only 20 MHz is still used.

1945: Standard time announcements were broadcast using telegraphic code.

1948: WWVH opened on the island of Maui in Hawaii. It wasn’t until 1968 that WWVH moved to Kauai, due to damage from the ocean. WWV and WWVH broadcast on the same frequencies, so they use different voices for their announcements to help listeners distinguish between the two stations. WWV uses a man’s voice, and WWVH broadcasts a woman’s voice.

1950: Voice announcements of time were added to WWV.

1963: WWVB opened in Fort Collins, Colorado.

1966: WWV moved from Beltsville, Maryland, to Fort Collins, where it shares land with WWVB. The new site was closer to NIST’s labs in Boulder, Colorado, and improved the transmitted frequency with the use of atomic oscillators at the site.

1967: The station switched from transmitting local time to Greenwich Mean Time (GMT), and began transmitting its current format of Coordinated Universal Time (UTC), 1 year later.

1971: WWV started making time announcements every minute, rather than every 5 minutes.

lines. From the HF bands, WWV puts out 2,500 – 10,000 W on several frequencies (each on separate transmitters) to ensure the best possibility of being heard by its millions of listeners through hindrances like atmospheric conditions — conditions altered by the time of day — and interference caused by the seasons. NIST stations use incredibly precise atomic clocks to keep their time signals accurate.

In addition to broadcasting precise time signals, WWVB broadcasts standard frequencies, UT1 time

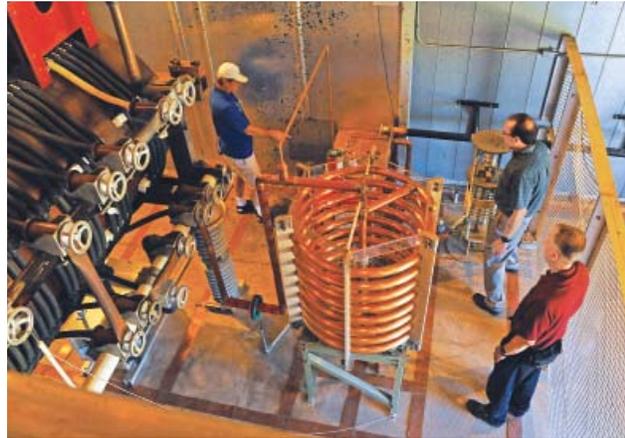
corrections, geophysical alerts, and more. The time-of-day broadcasts can even be heard by calling a dedicated phone number, which receives around 2,000 calls every day. Musicians can actually listen to WWV to tune their instruments, as the station also broadcasts the 440 Hz tone, which is the musical note A above middle C. WWV’s signal is so reliable that NIST maintains a web page (www.nist.gov/time-distribution/radio-station-WWV/WWV-and-WWVh-broadcast-outages) dedicated to recording the few incidents that



Timing, signal-generation, and transmitting equipment can be found in the radio station’s main building.



Inside of WWV.



The helix house that powers WWV's antenna array.

broadcasting has been interrupted for more than 5 minutes, since the year 2000 (on average, it occurs less than twice per year).

WWV and Ham Radio

Thomas Witherspoon, K4SWL, first heard WWV as a child, when his father tuned to the shortwave station to listen to the time broadcasts and manually set his watch every Sunday. "I found the metronomic ticks hypnotic then," Witherspoon said. "And I still do." He founded the charity Ears to Our World (which closed in 2019), that sent shortwave radios to students and teachers in third-world countries, and is currently a blogger for *The SWLing Post* (<https://swling.com/blog>), a website for fans of shortwave radio. As a kid, Witherspoon was amazed that the signal from WWV could be heard on his father's vintage RCA 6K3 console radio from over 2,000 miles away.

When Witherspoon was a child, many hams discovered the hobby through shortwave. Whether they were building a kit, tuning around the bands, or fixing up an old radio, they could rely on WWV's steady signal to confirm that they were receiving signals, and everything was working correctly. Witherspoon was given a Zenith Trans-Oceanic radio by his great aunt when he was 8 years old, leading him to a lifelong love of shortwave listening and an interest in amateur radio. He said, "WWV has been a constant companion in my radio world."

The era of radios like the Zenith has ended, but as technology has evolved, so has amateur radio. Fewer operators are getting their start through shortwave, or even through kit-building or homebrewing, as their predecessors once did. Many operators today are drawn to modern technology, enjoying the convenience of



WWV Chief Engineer Matt Deutch, NØRGT, checks the equipment.

digital modes like FT8 and JT65. As times change, some fear stations like WWV could get left behind.

Averted Closure

In its 2019 fiscal budget to Congress, the Trump administration proposed cutting NIST's budget, which would have resulted in the closure of WWV, among other branches of NIST. Witherspoon explained at the time, "If WWV and WWVH were to close, those of us who rely on these stations as a point of reference for time, as well as propagation, navigation, astronomy, and receiver calibration, would have to find alternatives."

As technology has advanced, innumerable devices now rely on the internet and Global Positioning System (GPS) signals for timekeeping, making some see WWV as a relic of the past. However, the use of GPS and the internet for timekeeping has downsides. Unlike GPS, WWVB's low-frequency signal can reach clocks and watches inside buildings without issue. The

internet already syncs with millions of devices automatically, but it's dependent on the availability of a signal. Both could fail in times of emergency, whereas WWV would still be functional.

The devices reliant on WWVB are inexpensive, don't require much power, and work without an internet connection. Witherspoon compared these options by explaining that his bedside alarm clock automatically adjusts to WWVB and only requires two AA batteries for around 2 years of functionality, while his GPS-enabled Apple Watch needs to be charged every 2 days and must have an unobstructed signal to satellites in order to work.

The Fate of WWV

Time hasn't run out for WWV just yet. WWV and its companion stations remained open throughout the 2019 fiscal year. Gail Porter, retired Director of Public Affairs for NIST, explained, "The Consolidated Appropriations Act of 2019 provided \$724.5 million for NIST's Scientific and Technical Research and Services, the budget category that funds the radio stations." More information about the legislation that funded WWV and

related stations for the 2019 fiscal year can be found at www.congress.gov/congressional-report/116th-congress/house-report/9/1?overview=closed.

Commenting on the decision to fully fund WWV, Witherspoon said it was "possibly an indication that the radio community's voices were heard by those making budget decisions."

The Northern Colorado Amateur Radio Club (NCARC) worked with NIST to organize WWV's centennial celebration. NIST hosted a small event on October 1, 2019, while NCARC operated special event station WW0WWV on station property. After 100 years, it's clear that whatever WWV's place is in annual budgets, it will always have a place in radio history.

All photos courtesy of NIST.

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