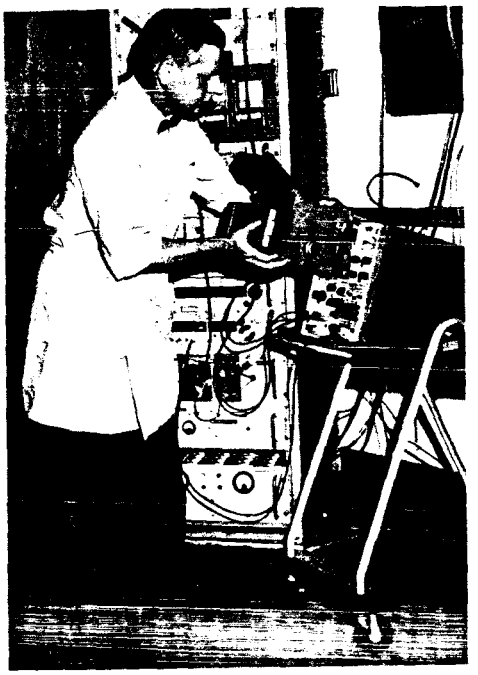
WWVB adds

TIME CODE

to broadcasts



David H. Andrews prepares to photograph an oscilloscope presentation of the time-code modulation broadcast. Mr. Andrews makes several such checks daily to verify that the proper modulation pattern is being applied.

■ Time information has been broadcast by the Bureau since 1935, with many subsequent improvements in its accuracy and precision. As a further step in improving its service to users of frequency and time broadcasts, NBS radio station WWVB, Fort Collins, Colo., is now broadcasting time-of-day information. The broadcast gives the minute, hour, day of the year, and milliseconds difference of UT2 from the uniform time scale of WWVB in a carrier level-shift time code, a system devised by David H. Andrews, who heads the Bureau's Frequency-Time Broadcast Services Section.

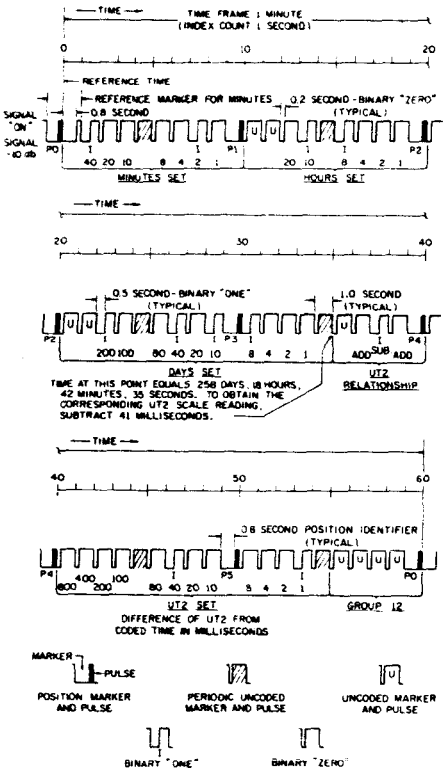
The new code permits users all over the United States to record events automatically against a uniform time scale. WWVB's signals thus constitute, in effect, the standard clock for the United States. For example, in geophysical research, with widely spaced recording stations, event recordings can be synchronized with greater accuracy than ever before. It is also possible to date and time communications traffic on multichannel recorders with pinpoint accuracy—an important legal consideration for some agencies and an important research consideration for others.

The Radio Standards Laboratory (RSL) of the NBS Institute for Basic Standards is responsible for establishing, maintaining, and disseminating the Nation's standards of frequency and time. The thousands of users of these standards in the electronics industry include manufacturers of electronic equipment, electric power companies, and radio and TV networks. Many government agencies, such as the Federal Aviation Agency, the Department of Defense, and the National Aeronautics and Space Administration, also make extensive use of the service.

WWVB is one of four radio stations operated by RSL's Frequency-Time Broadcast Services Section. WWVB might be called the NBS master station, since the broadcasts of WWV (Greenbelt, Md.) and WWVH (Maui, Hawaii) are, in effect, controlled by the signals from WWVB. Redundant information also is received from WWVL, which is an experimental VLF station likewise located at Fort Collins, Colo. WWVB and WWVL, in turn, are tied directly by phaselock equipment to the United States Frequency Standard (USFS), an atomic device located in the Boulder (Colo.) Laboratories. WWVB broadcasts include a standard carrier frequency and standard one-second intervals derived from the USFS.

The new modulation of WWVB signals is obtained from three identical time-code generators, provided jointly by the Bureau and the U.S. Department of the Interior. These generators, the outputs of which are constantly compared with each other, provide the degree of reliability so essential to standard frequency and time broadcasting.

The time-coding equipment is unique in several respects. The units receive as inputs the same frequency (60 kHz, without offset) which is broadcast from WWVB. This frequency is divided to obtain time pulses occurring at regular one-second intervals, instead of the slightly longer intervals heard on broadcasts of stations whose carrier frequencies are offset from their nominal values. This offset is changed each year so that time pulses derived from these offset frequencies



Time-scale representation of carrier level-shift modulation. BCD code gives time, day, and difference between WWVB and UT2 time scales.

occur at a rate throughout each year which approximates the slightly variable scale known as UT2. (UT2, also known as Greenwich Mean Time, is the adjusted mean solar time scale based on the rotation of the earth.)

Station identification is still made by a characteristic carrier phase advance followed by an identical retardation at periodic intervals, without keyed interruption of the carrier.

Two new features have been incorporated, one of which is automatic "UT2 difference" insertion. Differences of UT2 from the uniform time scale of WWVB are obtained from U.S. Naval Observatory data and are entered on dials on the front panel of the time-code generators by the operators each day at any convenient time. At exactly 2400 UT these differences are entered automatically into the generator circuitry and control the code broadcast during the subsequent 24 hours.

The other feature is automatic 200-ms time retardation. When a time retardation is required on the first of a month, in order to keep the uniform scale within 0.1 second of UT2, the operator sets a switch during the day preceding the time adjustment. Exactly at 2400 UT the 200-ms time retardation is automatically programmed into the time code being generated.

Except for the UT2 difference information, these generators operate in very similar fashion to other time-code generators which are used for time recording on the Atlantic and Pacific Missile Ranges and Satellite Tracking Stations. They provide time-of-day information in minutes and hours, as well as the day of the year.

The code, binary coded decimal (BCD), is synchronized with the 60 kHz carrier signal and is broadcast continuously. The new system replaces the method whereby seconds pulses of uniform width were broadcast by level-shift carrier keying. The carrier is no longer interrupted for keyed station identification, since the characteristic phase advance by 45° at 10 minutes after every hour, followed by a similar phase retardation 5 minutes later, continues to identify the station.

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