Correspondence

Notice of Time Signal Adjustment
WWV/WWVH New Timing Code on WWV

In order to bring the time signals of WWV/WWVH and other stations into closer agreement, a retardation phase adjustment of the time signals radiated by WWV/WWVH is now being made at 0000 UT on January 1, 1961. The retardation will be precisely 5 milliseconds.

It is expected that such adjustments in the time signals will be made as infrequently as possible and preferably at the beginning of each calendar year when necessary. The time signals are locked to the broadcast frequency.

In 1961 it is planned to maintain the frequency stable to 1 part in $10^8$ and at the same offset value as before, i.e., -150 parts in $10^6$ with reference to the United States Frequency Standard.


On January 1, 1961, the National Bureau of Standards will commence a regular broadcast from WWV of a timing code which gives the hour, day, minute, and second (Universal Time), and which is locked in phase to the frequency and time signals. The code is a 36 Binary Digit 100 FPP Code carried on 1000 cycles per second. A complete frame size is 1 second. The code will be broadcast for 1-minute intervals and 10 times per hour. Except at the beginning of each hour, it immediately follows the standard frequencies of 440 c.p.s. and 600 c.p.s. The code was broadcast experimentally during the interval April to August, 1960, and is described in "Experimental Timing Code Added to WWV Broadcasts," NBS Tech. News Bull., vol. 44, no. 7, pp. 114–115; July, 1960.

An announcement, "Time Code on WWV," is available on request.

NATIONAL BUREAU OF STANDARDS
Boulder, Colo.

Stability Criterion for Amplifier Moving in Space*

The linear network formula for feedback, 

$$A(s) = \frac{A_0(s)}{1 - B(s)A_0(s)}$$

with $s = s_0 + j\omega$, and with $H(s)A_0(s) = 1$ designating the point of instability, can, with $s = s_0$ be extended to cover the case when the amplifier of inherent amplification, $A_0(s)$, moves in space with the velocity $v$. The feedback path is then a radiation path with sufficient reflected power to make the stimulation, or negative resistance, compensate for the system loss. To make the formula apply, we must take into account the Doppler effect. However, we will find that for $\beta \ll c$, a linear system is able to repeatedly reach the instability point at a repetition rate dependent upon the Doppler shift $2\beta/\lambda_0$, where $\lambda_0 = 1/f_0$ and where $c$ is the velocity of light. We may formulate a stability criterion during any brief interval of assumed steady-state condition by means of the straight-forward network transformation

$$H(s) \rightarrow R(s) \rightarrow R(s) \rightarrow H(s)$$

Here $H(s)$ is the feedback transfer function for a feedback path exposed to Doppler shift. It is interpreted as the stimulation $R(s)$ of return frequency $\omega_0/2\pi$, transformed into the equivalent stimulation $R(s)$ of signal frequency $\omega/2\pi$. Finally, this stimulation is interpreted as a feedback factor, so that the entire system can be treated as a single frequency system. We may formulate the following criterion: A linear feedback system, in space, with radiation type feedback and an amplifier moving with a velocity $v$, very much less than that of light, remains stable when the return frequency differs from the transmitted generated output frequency by the Doppler shift $2\beta/\lambda_0$ unless $H(s)A_0(s) = H(s)A_0(s) = 1$, where $H(s)$ is defined by the requirement that the corresponding stimulation covers the system loss. The transformation, (2), implies the insertion of a fictitious frequency converter into the system, to make possible the treatment of Doppler stimulation at signal frequency. If a network element in form of a real frequency converter is inserted, as in Fig. 1.

* Received by the IRE, December 1, 1960.


1 Received by the IRE, August 2, 1960.


* Received by the IRE, December 1, 1960.

† Received by the IRE, August 2, 1960.

‡ Received by the IRE, October 28, 1960.

§ Received by the IRE, December 1, 1960.

World War II and the History of the Frequency Division.

* Submitted for review 8 April 1961.

† W. V. A. members have been designated a WAA (WWV/WVH Antenna Array) in the historical society in Germany.

‡ The frequency of the USFS was determined by the International Frequency Division of the National Bureau of Standards, Boulder, Colo.

§ The characteristics of the USFS, and its addition to time scales such as ET and UT2, have been described in a previous paper, to which the reader is referred for a complete discussion.

** The WWV and WWVH time signals are kept in agreement with each other. In addition, they are locked to the nominal frequency of the transmissions and consequently may depart continually from UT2. Functions are determined and published by the U. S. Naval Observatory. The broadcast signals are maintained in close agreement with UT2 by properly offsetting the broadcast frequency from the USFS at the beginning of each year when necessary. This system was commenced on January 1, 1961. A retardation adjustment of 20 milliseconds was made on December 16, 1959; another retardation adjustment of 1 millisecond was made at 0000 UT on January 1, 1960.

1 Received by the IRE, December 1, 1960.


3 Received by the IRE, August 2, 1960.

4 Received by the IRE, October 28, 1960.