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A Time Code for the Omega Worldwide Navigation System

Abstract—Time-of-day information could be added to the signals of the Omega worldwide VLF navigation system by means of a digital code. This could be valuable in resetting precision clocks and in monitoring them for malfunction. Also, Omega's worldwide coverage could then provide timing for automatic recording of data, such as geophysical information, in remote locations.

While most of the attention of this Special Issue is directed toward users of high-accuracy frequency and time (a few microseconds to 1 ms), the possible need for time-of-day information should not be overlooked. The high-accuracy time user tends not to worry about receiving time-of-day signals since the nature of his problem usually requires that he maintain a highly stable clock. Having set his clock initially with the aid of a precision portable clock, he maintains its synchronism to an external scale by checking it periodically, perhaps daily. Typically, this is done by observing the phase of a particular cycle of a stable broadcast signal such as a VLF carrier, noting the (small) errors, and adjusting when necessary. In principle, he can thus maintain timing accuracy to a few microseconds indefinitely without time-of-day information—provided his clock does not stop! If this happens, he must reset again with the aid of another portable clock visit because VLF signals do not now contain usable resetting information to establish the correct second to a precision of the order of microseconds. In practice, the high-accuracy time user prefers not to wait for his clock to stop before checking its time with a portable clock to make sure undetectable errors have not crept in. These may occur, for example, if a malfunction causes correct VLF cycle identification to be lost and a resultant clock error which is some unknown number of carrier cycles.

Experimental multiple frequency methods have been devised to extend the VLF cycle identification technique so that much larger clock errors, amounting to 20 or more periods of the VLF carrier, may be recognized [1]. Even so, the local clock must be known to be correct to perhaps a few milliseconds. This can be determined successfully from other types of time broadcasts, such as from WWV. However, such signals tend to be intermittently available, require selection of one from several possible carrier frequencies, are not available in all desired parts of the world, and generally make demands in terms of operator technique.

The Omega VLF navigation system [2] is adapted to solving these problems by applying two procedures. First, the VLF multifrequency technique can be extended [3] to where observation of time of reception of the Omega carrier pulse envelope allows clock errors of a second or more to be detected with a precision of a few microseconds. Second, a time code may be added to the Omega format [4] to permit identification of time to the correct second, minute, hour, and even day and year on a recognized time scale.

The Omega system, when completed in 1974, will consist of eight transmitting stations, allowing access, for navigation purposes, to three or more stations anywhere in the world. Only one station is needed for timing purposes. The signals will be available 24 h a day on fixed frequencies, although not the same combination from each station to avoid interference. A time code as proposed would probably be broadcast once every 5 min with a frame length of 2 min. The other 3 min in five would be devoted to internal Omega synchronization and control data exchange. The time scale used by the Omega system will follow the International Atomic Time Scale as determined by the International Bureau of Time (BIH) in Paris. It will be traceable to the time scales of the U. S. National Bureau of Standards, Boulder, Colo., or the U. S. Naval Observatory, Washington, D. C.

An experimental time code format is being developed by the National Bureau of Standards for inclusion in the Omega North Dakota station broadcasts. It will be designed for use as previously described in conjunction with an Omega precise timing receiver [5]. Other uses for the time code in addition to precise timing also suggest themselves. For instance, by developing an inexpensive receiver and reset mechanism it could be used to keep ordinary wall-type clocks on time. It could also be used to supply time-of-day to recordings of geophysical and other events being monitored in remote locations and for which suitable timing is now difficult to obtain.

LOWELL FEY
Nat. Bur. Stand.
Time and Frequency Div.
Boulder, Colo. 80302

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