Design of Real Time Information Module based on Timecast of Broadcasting

YOUNG B. KIM¹, YOUNG K. LEE¹, KIL Y. KANG², DONG Y. YEOM²

¹Korea Research Institute of Standards and Science
1 Doryong-Dong, Yuseong-Gu, Daejeon, KOREA

²ESOM Inc. Co.
Buck San TECHNOpia 809, 434-6 Sangdaewon-Dong, Jungwon-Gu, Seongnam, KOREA

Abstract: In a modern control system, real time information is essentially required to assure reliable operation of the system. In order to achieve this goal, time broadcasts using a long-wave can be utilized in advanced nations, but there is no dedicated broadcasting system of a long-wave in Korea. In this work, we propose a small-sized module, which is synchronized to a timecast provided by commercial broadcastings, for the purpose of overcoming this domestic situation. The measurement results of a prototype module show that time difference from the national standard time is kept in two hundreds of millisecond.

Key-Words: real-time information, long wave broadcasting, synchronize, timecast, tone signal, time interval

1 Introduction
In a modern industrial society, the operational reliability of most of the systems is guaranteed only when they are run on a globally synchronized time base; otherwise, unwanted results may arise. In this sense, the importance of timing sources that provide reliable real time information is increasing more than before. For this purpose, long wave broadcasting, which can be received indoors with small-scale devices alone, is being used in some countries[1]. Due to the enormous costs of constructing dedicated broadcasters and other problems, however, most countries use short wave broadcasting or Global Positioning Systems (GPS); however, these options also entail the problems of sizable antenna and relatively high-priced receiving devices[2],[3]. Against this backdrop, this study proposes a new reference-time distribution method where, without additional capital expenditure, real-time information (e.g. year, month, day, hour, minute, second) can be provided for industrial fields and other areas—in the same function as exclusive long wave broadcasting and at reasonable costs—through synchronization with tone signal-type timecast services offered by existing broadcasters every hour.

2 Design of System
To enhance recognition accuracy, in Korea, the timecast signal of most of the public broadcasters are designed to transmit a 440 Hz tone signal that lasts for 200 ms three times followed by one 880 Hz o’clock-signal tone signal for 500 ms. Some attempts were made before to use this timecast signal and maintain the system time synchronized to this type of timecast[4]. In this study, we design and implement a Real-Time Information Module (RTIM), which is synchronized automatically with hourly timecast services by broadcasters and provides similar information to those of long wave broadcasting receivers, at a laboratory level as illustrated in Fig. 1 and 2. The implemented RTIM is different from an ordinary RTC(real-time clock) in that the user does not have to enter the current time and in that accumulated errors are automatically erased over time; and this makes the current time be always within a certain error range. RF reception is a method that checks whether the timecast signals for frequencies with field strength, enabling consecutive circuit operation among broadcasting frequencies predefined by region, can be extracted or not. It automatically selects the frequency for a given region; the IF signals go through each of the filters for 440 Hz
(preliminary signal) and 880 Hz (o’clock signal), and the o’clock signal for the synchronized signal (1 pph) is extracted.

The time information producer has its own time-generation clock, which makes it possible to maintain its time even when the sync. signal (synchronization-purpose o’clock signal) from outside cannot be received. When external power cannot be supplied, built-in power is provided for major parts related to the time information producer, enabling uninterrupted maintenance of its own time. When external power is supplied, not only a synchronized signal is immediately obtained from the synchronized signal extractor but also the internal clock of the real-time information producer synchronizes its own time to the external time. Provided by the RTIM through this synchronization process, the real-time information is structured to correct the accumulated errors, caused by its own clock. Of course, hourly timecast signals offered by timecast broadcasting services simply point out the o’clock location, making it impossible to tell what time the location represents; hence, the real time has to be entered in advance through an external interface from the production phase of the module. With the real time entered in this manner, the current time is always maintained by the RTIM’s built-in power; when synchronization is performed by broadcasting timecast signals, the module’s own time is set to be returned to the o’clock location within a range of ±30 minutes. In other words, if the module’s own time is less than 30 minutes behind the o’clock at the time of synchronization, the time is reset to the o’clock of the next hour. On the other hand, if the module’s own time is less than 30 minutes ahead of the o’clock, the time is reset to go back to the o’clock of the previous hour. Therefore, if the RTIM’s own time is maintained within the error range of less than 30 minutes from the broadcasters’ time, the time can be restored to the o’clock by broadcasting a timecast at any time. Given that the accuracy (relative frequency) of a used crystal generator is at the level of \(10^{-7}\), the error—calculated by the general formula, which represents the accuracy—is maintained at less than 30 minutes theoretically even when correction is made for about a year[5]. In this vein, it is expected that receiving broadcasters’ timecast signals within a considerable period of time (e.g., about 6 months) does not negatively affect the operations of a regularly synchronized module.

### 3 Measurement

To evaluate the synchronization performance of the RTIM, the changes in time differences between the second time signal (1 pps) from the standard and the extracted signal from the module’s second signal (1 pps) are measured; each signal is entered to the start and stop terminals and automatically measured by a computer program as described in Fig. 3.

In order to improve the reliability of measurement, the 10 MHz sine wave signal of a cesium (Cs) atomic clock (used as a standard) is utilized as the external input signal for the counter.

The results of the measurement are presented in Fig. 4. As shown in Figure 4, it is considered that the RTIM is synchronized so well because: (1) it is synchronized to
the reference time under 50 ms, after more than one hour from its connecting to the power, at the moment when it receives the timecast; (2) and even after more than 20 hours, the time difference also shows the characteristic of the maximum variation under 80 ms with the overall slant near to zero.

Fig. 3 Configuration Diagram for Measuring RTIM’s Timecast Signal (1 pph) and Second Signal Output (1 pps).

![Configuration Diagram](image)

The graph indicates that the calibrated accuracy of the RTIM internal generator is about $6 \times 10^{-6}$, and this implies that the time can be kept within less than 0.5 seconds if synchronization is executed by receiving the timecast signals at least once every 12 hours.

Fig. 4 Time Difference Features of RTIM’s output (1 pps).

![Graph](image)

4 Conclusion

This study has suggested broadcasting timecast-based RTIM as an alternative to exclusive long wave broadcasting for providing real-time information, and described how to design and produce the device. The real-time distribution method proposed here incurs very little cost, as the timecast service signals from commercial broadcasting services can be utilized without building additional facilities; unlike in ordinary real-time clocks, the current time does not have to be entered by users themselves, and it is always maintained within a certain error range with the elapse of time. The RTIM, produced experimentally in this study, is measured to show a time difference change of around 80 ms.

The performance of this RTIM still somewhat lags behind compared to the dedicated long wave broadcasting-based time information service. It is believed, however, that there are various areas where this technical performance level of RTIM can be accepted; its timing features are expected to be enhanced in a future research by reducing accumulated errors using a proper compensating algorithm.

References:


