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REAL TIME DISTRIBUTION USING RADIO TIME TONES OF COMMERCIAL BROADCASTING SYSTEM

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Abstract – In a modern control system, real time information is essentially required to assure reliable operation of the system. In this work, we propose a small-sized module, which is synchronized to a timecast provided by commercial broadcastings, for the purpose of distributing the accurate time information to the industrial field. The measurement results of a prototype module show that time difference from the national standard time is kept in thirty milliseconds under the normal condition.

Keywords : timecast, radio tone, synchronization

1. INTRODUCTION

In a modern industrial society, the importance of timing sources that provide reliable real time information is increasing more than before. For this requirement, dedicated 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, however, most countries use short wave broadcasting or Global Positioning Systems (GPS) [2]. To overcome the partial weakness of GPS, this study proposes a new 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 similar 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. BASIC DESIGN OF MODULE

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 ㎳ three times followed by one 880 Hz o'clock-signal tone signal for 500 ㎳. Some attempts were made before to use this timecast signal and maintain the system time synchronized to this type of timecast [3].

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. The implemented RTIM is different from an ordinary real-time clock (RTC) 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 module 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 oscillator is at the level of several tens of ppm, 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 [4].

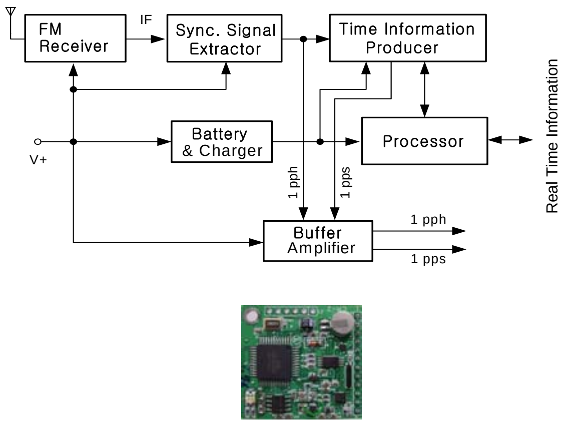

Fig. 1. Block diagram and picture of the designed RTIM.

The commercial RTC, used as the time information producer in the designed RTIM, has both analog and digital calibration functions. The accuracy of the embedded oscillator to the RTC can be improved to a few tens of part per million (ppm) through analog calibration. The accuracy can be more improved through the digital calibration by compensating the frequency offset which is estimated by the measured time difference between the time of the received timecast and that of the RTC.

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 as shown in Fig. 2: each signal is entered to the start and stop terminals and automatically measured by a computer program.

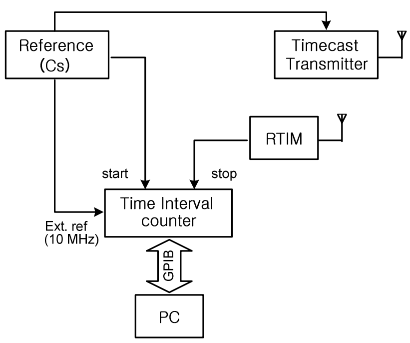

Fig. 2. Block diagram of time difference measurement system between the NST and RTIM's output (1pps).

The comparison measurement result of RTIM(1 pps) which is locked to the timecast of commercial broadcaster(EBS) are presented in Fig. 3.

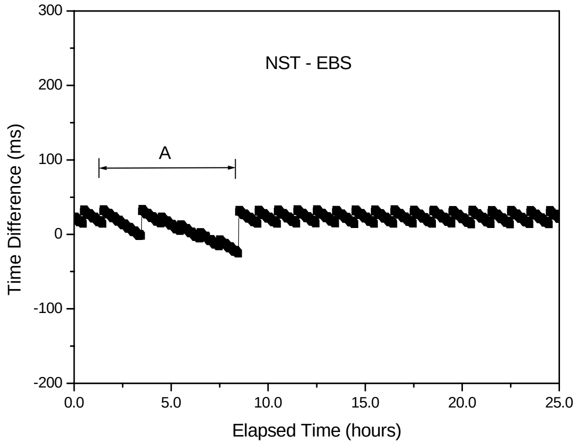

Fig. 3. Time difference features of RTIM's output (1pps)

As shown in Figure 3, it is considered that the RTIM is synchronized so well because: (1) it is synchronized to the national standard time (NST) under 30 ms, after it receives the timecast; (2) and even after more than 25 hours, the time difference also shows the characteristic of the maximum variation under 30 ms per 1 hour.

The time difference feature can be divided into two parts; the first one (designated as A) is the period when the timecast is not received or broadcasted (off-air), and the other is the normal operating period.

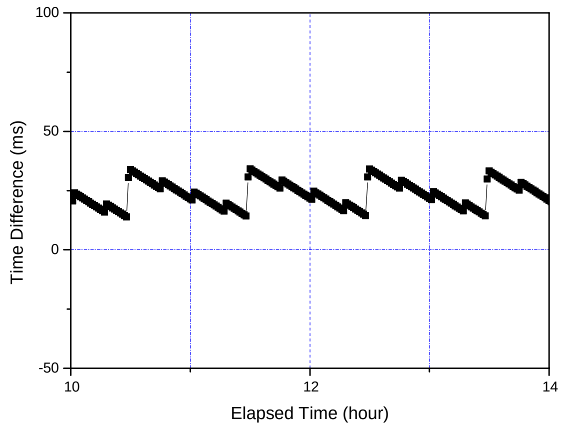

Fig. 4. Enlarged graph of Fig. 3 for the period from 10 to 14 hour.

The graph indicates that the calibrated accuracy of the RTIM internal oscillator is about several ppm, and this implies that the time can be kept within less than 0.4 seconds if synchronization is executed by receiving the timecast signals at least once every 12 hours.

As shown in Fig. 4, the digital calibration is automatically achieved by 15 minute interval and this improved the performance up to about 50%.

4. CONCLUSIONS

In this paper, we presented a 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 of under 30 ㎳ in the case of the normal receiving period.

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 technique.

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