

TV Frame Pulses Used for Precision Time Synchronization and their Noise Distribution.

Torino, February 23, 1970

1) *Few years ago it was proposed to use some television pulses in order to achieve a better synchronization between laboratories keeping time scales.*

This method was described by J. Tolman et al. [1], and was successfully tested in Czechoslovakia. In the last two years wider experiments were performed in Europe, during some transmissions, as those for the Olympic Games, Mexico, 1968 or for the Apollo 11 launch (1969, July).

The same method is used on a regular basis between standard time laboratories. This particularly occurs in Italy between Turin, IBF and Rome, IAM; in USA, between the NBS standard station WWV in Fort Collins and the Boulder laboratories [2]; in Paris, France at the B.I.H. and in Braunschweig, Germany at the P.T.B.

This letter does not concern the timekeeping results but rather some noise characteristics of pulses used. This knowledge is useful in order to find the best technique and the best statistics to be used or to evaluate the system limits.

The analysis method used is the time domain technique proposed by D. W. Allan [3] for noise classification.

2) *The data used in the analysis were gathered at the Paris Observatory and three other laboratories, the IEN, Turin; ISPT, Rome; and URE, Prague; whose kind cooperation enabled this analysis.*

Counters with resolution of 0.1 μ s were used.

3) *The data obtained in the four laboratories were analyzed separately, the television generator drift being previously removed. The particular standard deviation, as defined in reference [3], versus the period of sampling, T, is given in fig. 1. For T greater than a few seconds, the typical result was flicker of phase noise at a level of about 350 ns for $\langle \sigma^2(N=2, T, \tau) \rangle^{\frac{1}{2}}$. The initial value of τ was about 10 ms. The European frame frequency being 50 Hz, the measured intervals range between 0 and 20 ms.*

This noise level seems to be due mainly to the TV synchronization generator used: the figures are about the

same, regardless the very different lengths of the radio links involved, which cover nearly all of Europe.

In the same figure the dotted line represents the results when the analysis is performed on a video-recorded TV program.

4) The lowest set of points is the same analysis performed on the difference between readings taken in two laboratories at the same moment.

These differences are the essential information for time keeping purposes and for occasional remote time synchronization. Further, the stability of these differences probably represents the limit of precision achievable with the present system and paths considered, the TV generators instability being previously removed.

Though the counters only have a resolution of 100 ns, their contribution is only of minor significance for T equal to 1, 2 and 4 s. The noise for $T > 4$ s is apparently still flicker of phase noise, but the level of the above defined standard deviation is about 35 ns.

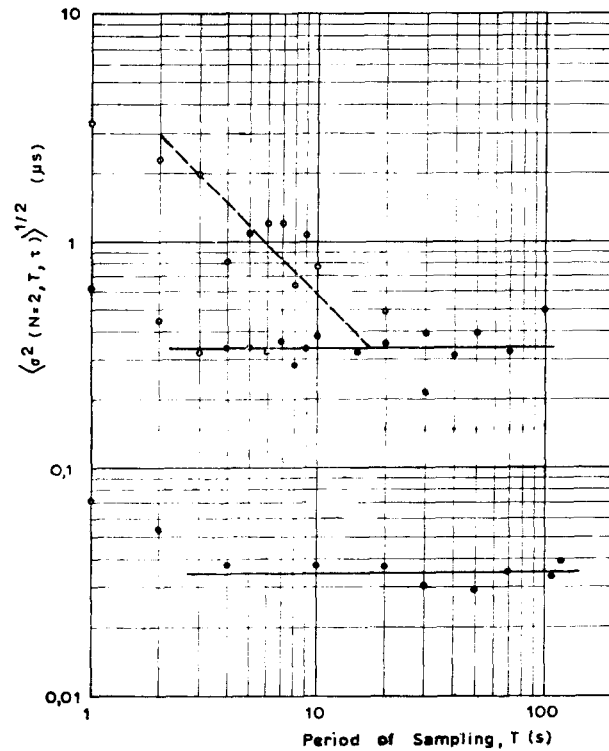


Fig. 1.

In conclusion the figure indicates that it appears possible to maintain time synchronization between two points separated at least 1 000 km to better than 0.1 μ s, and that for optimum data usage at least 4 adjacent points should be averaged when using counters with 0.1 μ s resolution.

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BIBLIOGRAPHY

- [1] J. TOLMAN, V. PTACEK, A. SOUCEK, R. STECHER: *Microsecond clock comparisons by means of TV synchronizing pulses.* - « IEEE Trans. », IM-16, n. 3, 1967, pag. 247 ÷ 254.
- [2] N.B.S. - Special Publication 236: *Frequency and Time Broadcast Service* 1969.
- [3] D. W. ALLAN: *Statistics of Atomic Frequency Standards.* - « Proc. IEEE », vol. 54, 1966, pag. 221 ÷ 230.

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