International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R SM.2080-0

(08/2015)

Precision of time information in output data of monitoring receivers

SM Series

Spectrum management

150 ITU 1865 - 2015

ITU International Telecommunication Union

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from http://www.itu.int/ITU-R/go/patents/en where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

(Also available online at http://www.itu.int/publ/R-REC/en)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	**Spectrum management**
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note*: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication
Geneva, 2015

RECOMMENDATION ITU-R SM.2080-0

Precision of time information in output data of monitoring receivers

(2015)

Scope

This Recommendation provides examples of possible measurement methods for the accuracy of the time information in I/Q data of a monitoring receiver.

Keywords

I/Q data, time stamp accuracy

The ITU Radiocommunication Assembly,

considering

a) that precise time information in I/Q data is of great relevance in the field of radio monitoring;

b) that ambiguities of the time stamp specification between users and different manufacturers may lead to misunderstanding of time information in the I/Q data;

c) that the internal clock of a monitoring receiver will drift if no measures are taken to maintain timing accuracy;

d) that, depending on the settings of a monitoring receiver, there are different time delays between the arrival of the signal at the RF input connector and the moment of the insertion of the precise time information in the I/Q data;

e) that a well-defined specification for precise time information in I/Q data, if adopted by manufacturers of radio monitoring receivers, will benefit users by providing an easier and more objective comparison of similar products from different manufacturers,

recommends

1 that the accuracy of the time information in the I/Q data stream is constant for every sample pair (I/Q) in order to be able to mark even short-duration, intermittent or pulsed signals with the same accuracy;

2 that the precise time information in the I/Q-data is referenced to the RF input connector of the monitoring receiver to prevent the signal propagation delay in the receiver from influencing the time stamp;

3 that the internal clock of a monitoring receiver is synchronized with a high precision clock;

4 that the accuracy of the time information in I/Q data of a monitoring receiver is defined by the deviation between the reference time and the time stamp provided by the receiver, expressed by mean value and standard deviation;

5 that the accuracy of the time information in I/Q data of a monitoring receiver and the measurement method is specified by the manufacturer in their datasheet. Examples of possible methods are shown in the annexes.

Annex 1

Definition of the time stamp accuracy of radio monitoring receivers

1 Scope

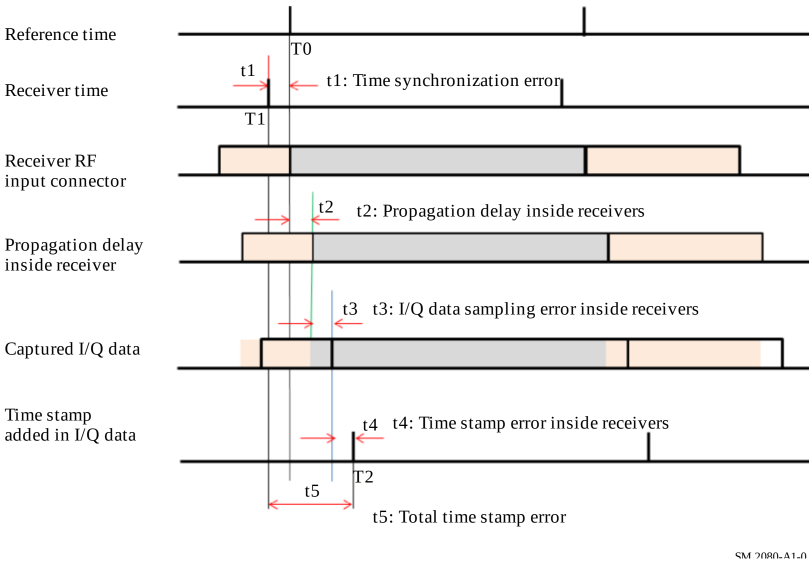
For a number of applications in the field of radio monitoring, highly precise time information in monitoring receivers is necessary. This Annex provides a definition of time stamp accuracy in the I/Q data of a monitoring receiver. This definition should be adopted as a common understanding of the terms and used in product technical data by all manufactures of radio monitoring receivers.

2 Clarification

The time stamp accuracy consists of two parts. One is how well the receiver is synchronized with the reference time; the other is how well the signal transmission time within the receiver is compensated.

FIGURE A1-1

Timing error with respect to the reference time during capturing I/Q data



In Figure A1-1, the receiver RF input connector gets the RF signal at T0 reference time, however the internal clock of a monitoring receiver has time synchronization error (t1) between its time and the reference time.

Propagation delay inside the receiver is described as t2 which represents the transmission time of the signal from RF input connector to I/Q data digitizer’s inputs. The digitizing clock of I/Q data has sampling error (t3). Finally the error of time stamping due to the internal processing may be exist (t4).

The total time stamp error of the I/Q data is t5 = t1 + t2 + t3 + t4.

3 Specification of time stamp accuracy to be listed in a data sheet

There are two parts of time stamp accuracy as stated above. The time synchronization accuracy (t1) and the runtime delay in the receiver (t2 + t3 + t4) should be distinguished in a data sheet separately. In some cases, however, it might be difficult to distinguish one from the other. If there are difficulties to list them separately, the time stamp accuracy can be listed as the total time stamp error (t5) as mean value and standard deviation.

Annex 2

Test procedure examples for measuring the time stamp accuracy of a radio monitoring receiver

1 Scope

This Annex describes the means and procedures required to verify that a time stamp in I/Q data of a monitoring receiver accurately reflects the reference time of a high-precision clock and gives examples of measurement procedures to establish better uniformity of specification across receivers from different manufacturers in terms of time stamp accuracy.

2 General aspects

The measurement is performed for the entire frequency range of the receiver focusing on the compensation of the internal time delay.

3 Measurement setup

FIGURE A2-1

Typical measurement setup for measuring the time stamp accuracy of a radio monitoring receiver, which has an external frequency reference input

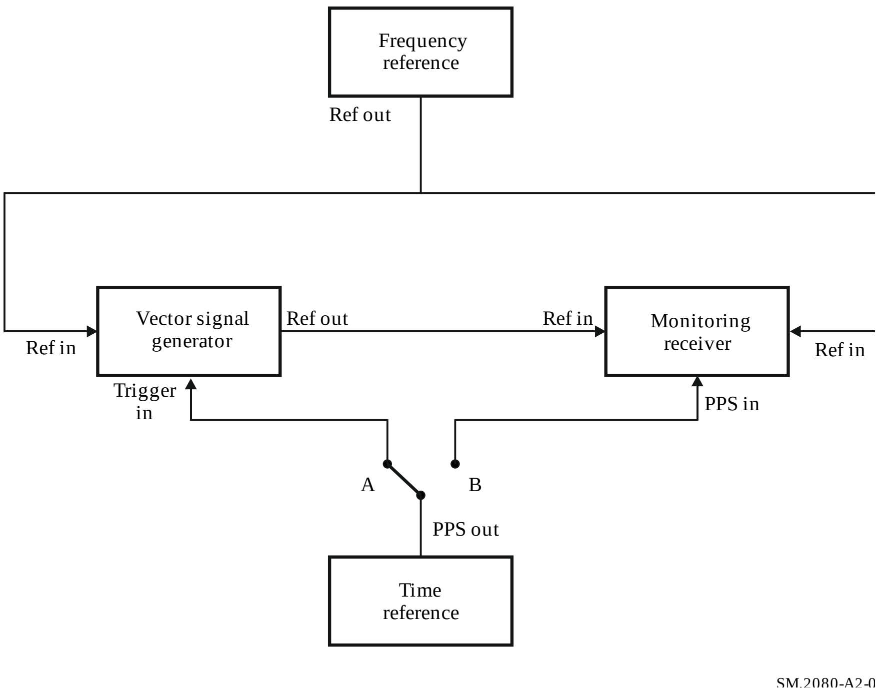
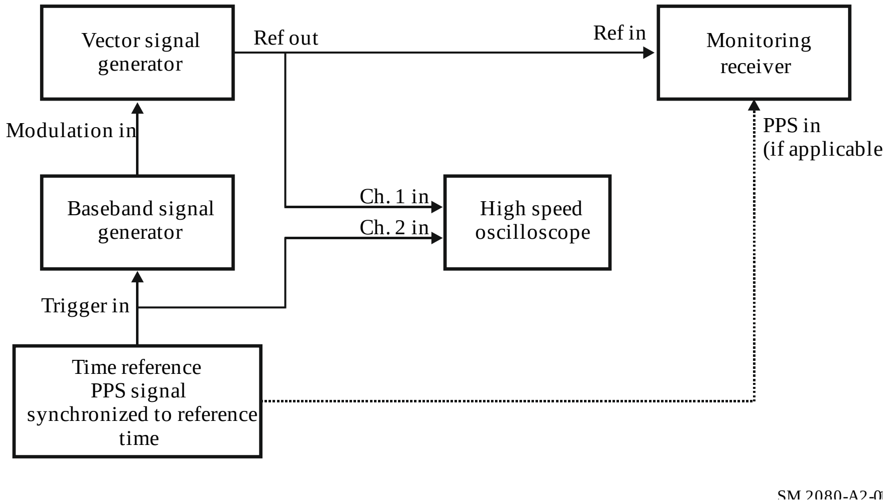


FIGURE A2-2

Typical measurement setup for measuring the time stamp accuracy of a radio monitoring receiver, which has no external frequency reference input



4 Description of measurement setups

Figure A2-1

A reference frequency from a common frequency reference is used to synchronize the signal generator and the monitoring receiver, whose time stamp accuracy is to be measured.

A common time reference (PPS = pulse per second) serves for two purposes: With the switch in position "B" it sets the time of the internal clock of the monitoring receiver correctly. The time is set only once at the beginning of the measurement. For the actual measurement the accuracy of the internal clock in the monitoring receiver is kept by the external reference frequency.

Then the switch is turned over in position A, where the PPS signal from the time reference triggers an output signal at the vector signal generator. The exact time of arrival of the signal at the RF input connector of the monitoring receiver is known. The time stamp accuracy is calculated from the difference between the known arrival time at the RF input connector and the time stamp in the I/Q data.

Figure A2-2

Time reference must be synchronized to reference time and generate a PPS signal.

Time reference triggers the baseband generator to alternate the modulation type of baseband signal by a PPS signal and is connected in parallel to a high-speed oscilloscope with sufficient bandwidth and sampling rate to display time variation of the RF signal.

The baseband signal is connected to a vector signal generator which generates RF signal.

The RF signal output is connected to both receiver and oscilloscope to verify the exact time of the transformation of the modulation type at the receiver's RF input connector. Thus transmission time from a PPS generator to the RF input connector must be measured by comparing the two inputs to the oscilloscope.

The time stamp accuracy is calculated from the time difference between exact arrival time at receiver's RF input connector and modulation transformation time based on the time information of captured I/Q data, however this accuracy includes both time synchronization accuracy (t1) and runtime delay inside the receiver (t2 + t3 + t4).

Time stamp accuracy will manifest as a deviation of the time stamp produced by the monitoring receiver from the reference time to be specified by mean value and standard deviation.

This requires multiple measurements of the same conditions over time.