Data report from SP

The measurements of the BIPM GPS calibration campaign at SP were performed during January 26, 2009 to February 4, 2009 (MJD 54857 to 54866). The measurements were coordinated and the report was written, by Kenneth Jaldehag of the SP Time and Frequency Lab.

1. Set-up and results of delay measurements of receivers

Z12T BIPM TRAVELLING RECEIVER

The Z12T BIPM travelling receiver set-up during operation is described in the "BIPM Calibration Guidelines" (Annex 1 and Figure 1 and 2). Figure 1 below shows the close up house 20-MHz and 1-pps set-up of the Z12T receiver.

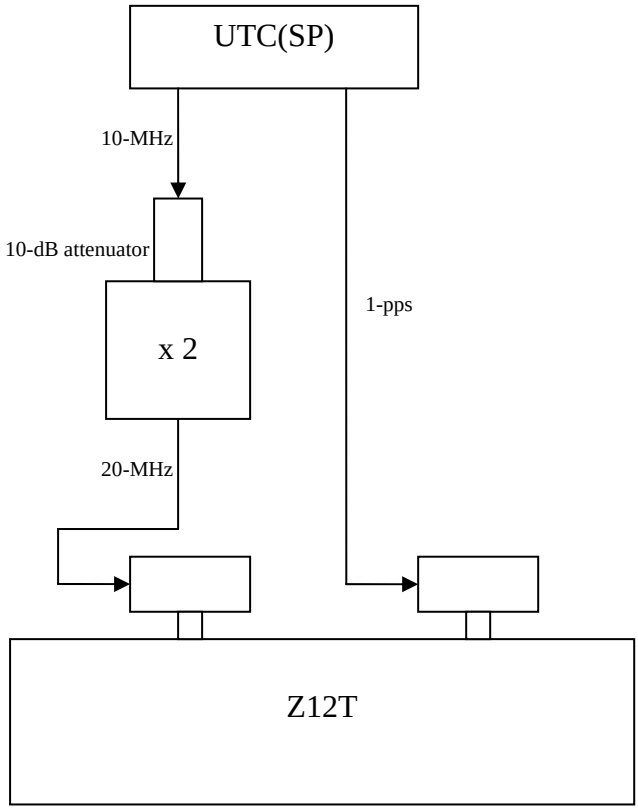

Figure 1: 1-pps and 20-MHz Z12T-input close set-up

During the campaign, two 1-pps set-ups were used at SP:

(1) Until about 14:00 UTC January 30, 2009 MJD 54861, the delay from UTC(SP) reference point to the 1-pps input BNC-connector of the receiver was 84.2 ns. The amplitude of the 1-pps signal was about 2.5 V in 50 Ohm.

(2) After about 14:00 UTC January 30, 2009 MJD 54861, the delay from UTC(SP) reference point to the 1-pps input BNC-connector of the receiver was 193.3 ns. The amplitude of the 1-pps signal was about 4.5 V in 50 Ohm.

Below, these set-ups are referred to as set-up (1) and set-up (2).

Measurement 3.1-1 according to Annex 3 of the "BIPM Calibration Guidelines":

Set-up (1):

Figure 2 shows the oscilloscope display during the 3.1-1 measurement using set-up (1) before operation of the receiver. **As the used oscilloscope did not have the possibility of reverting the input signal, the measurement was related to the 20-MHz falling edge zero. This concerns all measurements involving inverted measurements in this report.**

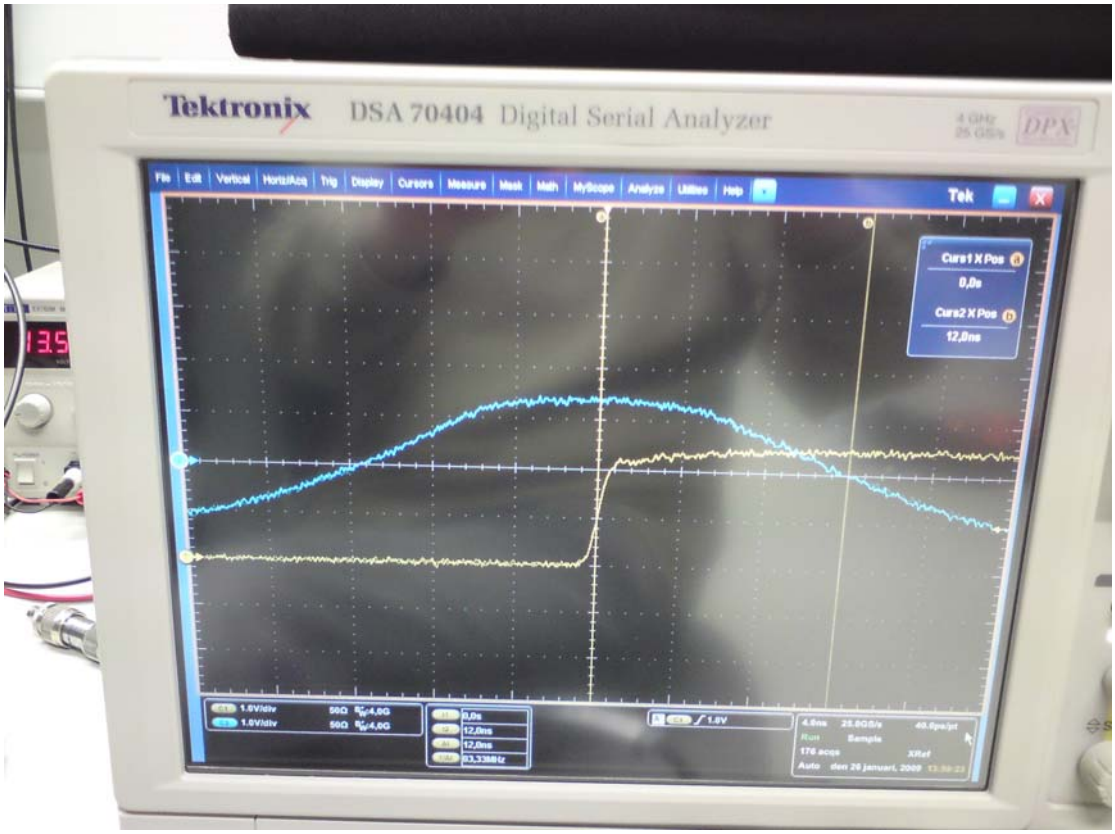

Figure 2: Measurement 3.1-1 before operation of the receiver, 1-pps set-up (1)

The phase difference between the 1-pps 1V crossing and the following 20-MHz falling edge was **12.0 ns**. Exchanging the channels gave the same result.

Set-up (2):

Figure 3 shows the oscilloscope display during the 3.1-1 measurement using set-up (2) after the operation of the receiver. The phase difference between the 1-pps 1V crossing and the following 20-MHz falling edge was **2.4 ns**. In the "BIPM Calibration Guidelines" it says that this value should be between 5 and 20 ns. If it is not, a delay line should be added to the 20-MHz cable. This was not done since the 1-pps set-up was changed in a hurry without any check of its condition or relation to the 20-MHz.

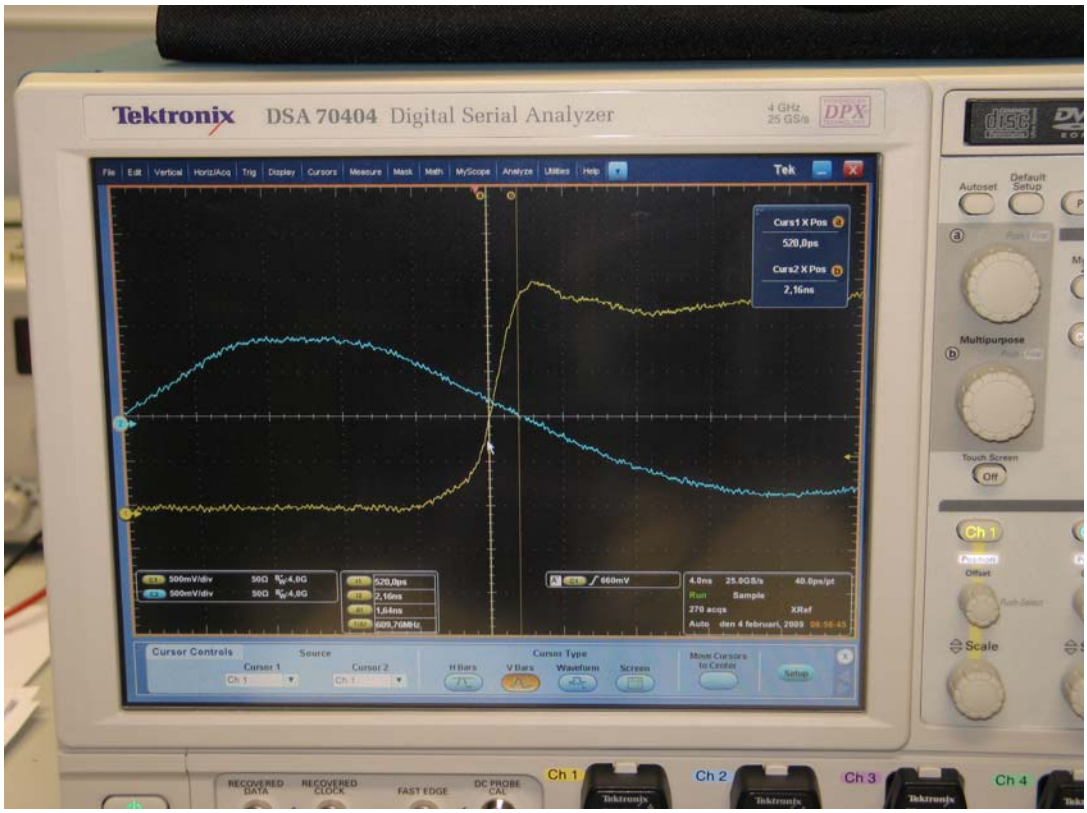

Figure 3: Measurement 3.1-1 after operation of the receiver, 1-pps set-up (2). Notice in the graph that the cursor position of the 1-pps pulse is not exactly at the 1V crossing.

Measurement 3.1-2 according to Annex 3 of the "BIPM Calibration Guidelines":

Set-up (1):

Figure 4 shows the oscilloscope display during the 3.1-2 measurement using set-up (1) before the operation of the receiver. The phase difference between the 1-pps 1V crossing and the following 20-MHz rising edge was **31.8 ns**.

The difference between measurements 3.1-1 and 3.1-2 is in this case 31.8 ns - 12.0 ns which equals 19.8 ns.

Set-up (2):

Figure 5 shows the oscilloscope display during the 3.1-2 measurement using set-up (2) after the operation of the receiver. The phase difference between the 1-pps 1V crossing and the following 20-MHz rising edge was **23.2 ns**.

The difference between measurements 3.1-1 and 3.1-2 is in this case 23.2 ns - 2.4 ns which equals 20.8 ns.

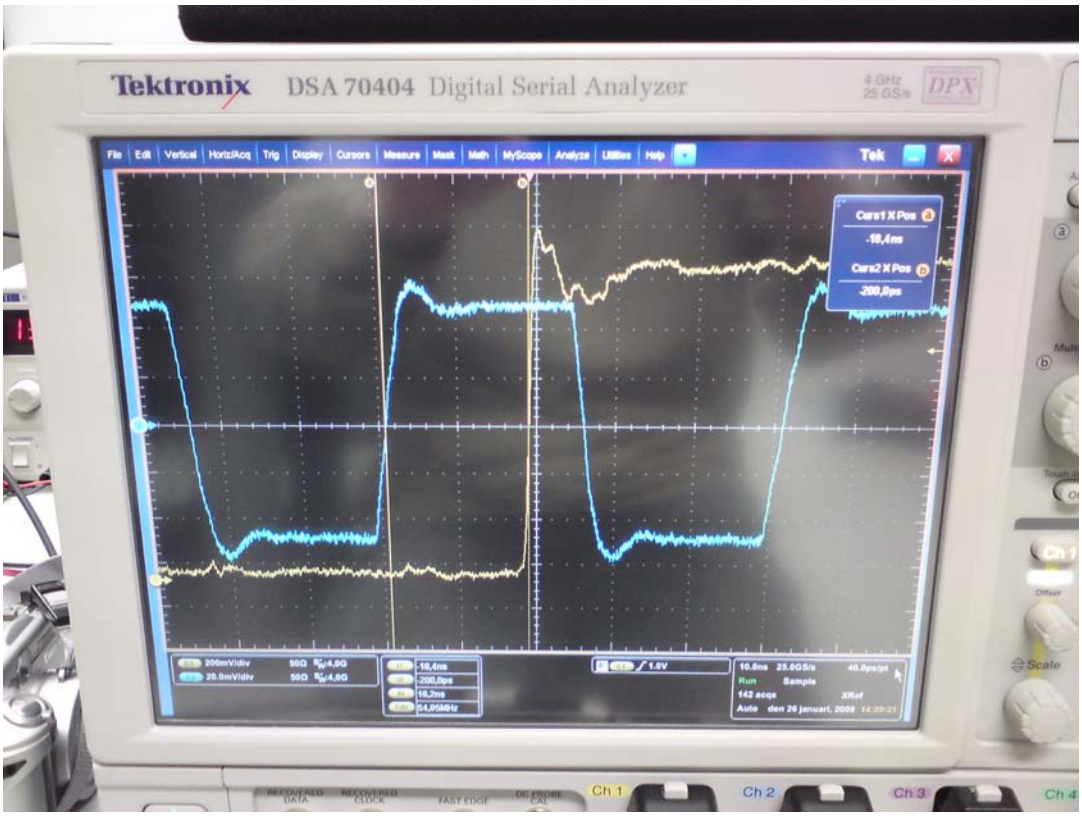

Figure 4: Measurement 3.1-2 before operation of the receiver, 1-pps set-up (1)

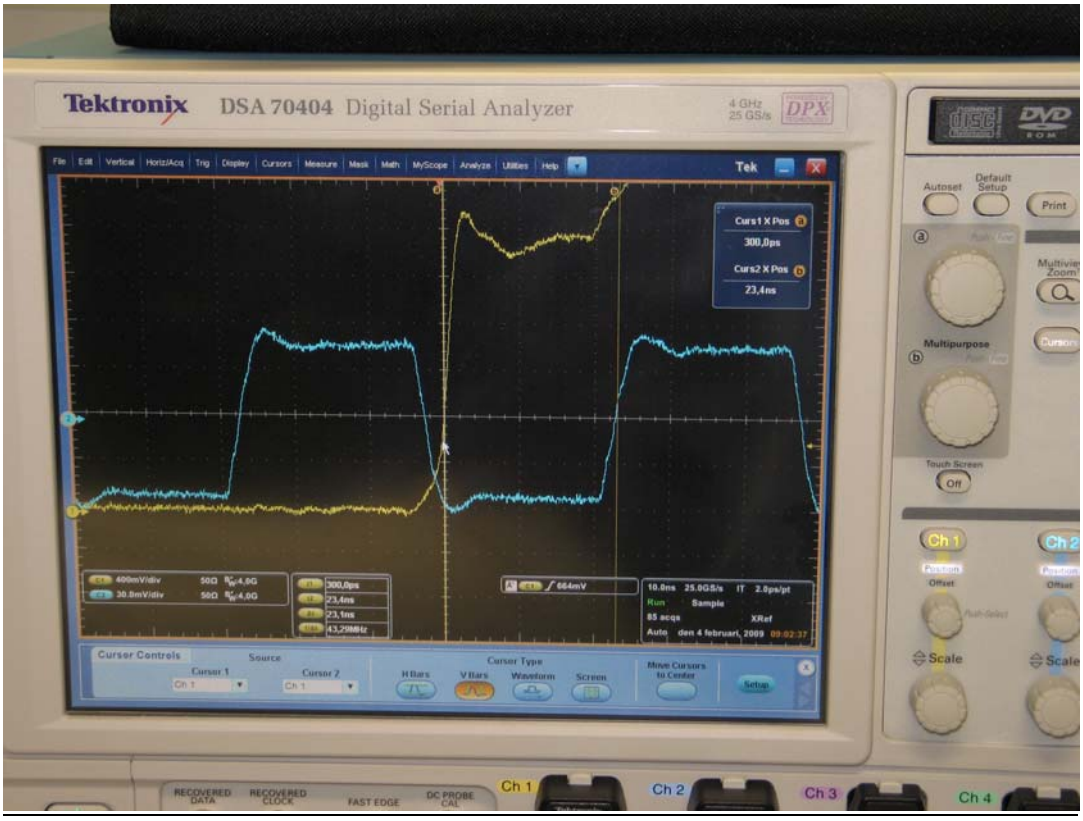

Figure 5: Measurement 3.1-2 after operation of the receiver, 1-pps set-up (2). Notice in the graph that the cursor position of the 1-pps pulse is not exactly at the 1V crossing.

Measurement 3.1-3 according to Annex 3 of the "BIPM Calibration Guidelines":

The oscilloscope displays for these measurements are similar to the ones shown for measurements 3.1-1 and not shown here.

Set-up (1):

The phase difference between the 1-pps 1V crossing and the following 20-MHz falling edge reference signals was **12.0 ns**.

Set-up (2):

The phase difference between the 1-pps 1V crossing and the following 20-MHz falling edge reference signals was **2.8 ns**.

JAVAD SP-RECEIVER SP01

The Javad receiver set-up during operation is described in the "Javad-Annex" of the "BIPM Calibration Guidelines". Figure 6 below shows the house 5-MHz and 1-pps set-up of the Javad receiver together with the measurement set-up for measurement 3.3-3 (results given later in the report).

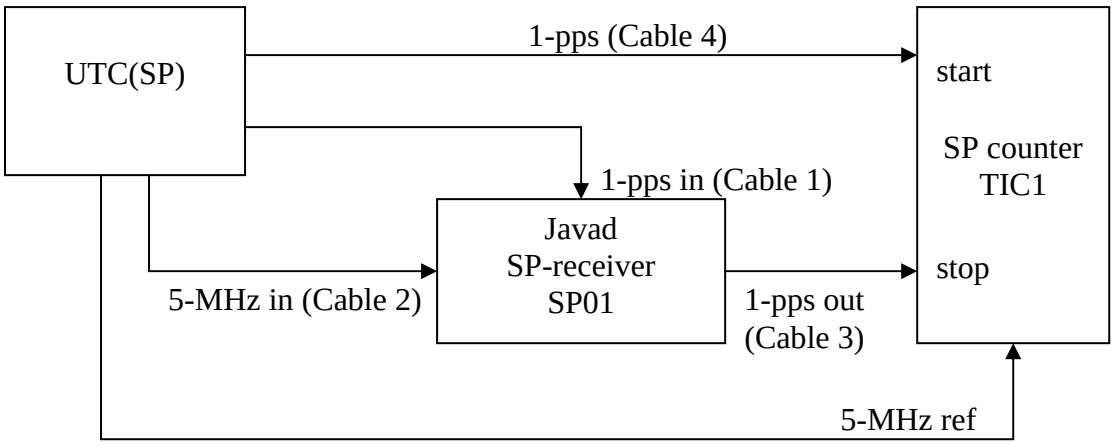

Figure 6: Set-up of Javad SP01 receiver during operation and measurement 3.3-3.

Measurement 3.3-1 according to "Javad-Annex" of the "BIPM Calibration Guidelines":

The phase difference of the receiver 1-pps input (cable 1) and the receiver 5-MHz input (cable 2) at the receiver connectors was measured to **137.6 ns**.

Measurement 3.3-2 according to "Javad-Annex" of the "BIPM Calibration Guidelines":

The time interval difference between the reference pulse (cable 4) and the receiver 1-pps input (cable 1) + the receiver 1-pps output (cable 3) was measured to **-2.2 ns**. The cable 1 and cable 3 was connected with a BNC-adaptor which delay is estimated to 0.1 ns and corrected for.

Measurement 3.3-3 according to "Javad-Annex" of the "BIPM Calibration Guidelines":

During operation of the receiver (according to Figure 6), the time interval difference between the reference pulse (cable 4) and the receiver 1-pps output (cable 3) was measured to **-14.4 ns**.

2. Coordinates of the L3 phase centre of the antennas

Coordinates are given in ITRF2005 epoch August 31, 2008.

BIPM Z12T:

X = 3328973.5020 m
Y = 761878.7265 m
Z = 5369051.4870 m

SP JAVAD:

X = 3328984.5425 m
Y = 761910.3299 m
Z = 5369033.8315 m

3. Data storage and distribution

The RINEX-data from both receivers as well as raw-data from the Z12T-receiver are stored on ftp://ftp.sp.se/time/pub/petit_Calibration_2009/ which can be reached via anonymous ftp.

Borås, February 23, 2009

Kenneth Jaldehag

Time and Frequency group
SP Technical Research Institute of Sweden