ASE 389P-7 Preliminary Exam 2

Posting Date: November 12, 2024

Exam Rules: Do all problems, writing or printing on standard 8 1/2 by 11 inch paper. Hand in the completed exam to Dr. Humphreys as you enter class on Wednesday, November 13, at 11 am, or slip it under his office door beforehand. No collaboration or consultation is allowed with any other person besides Dr. Humphreys. He is willing to discuss problems if he's available. You may use non-human outside sources (e.g., books). If you use such sources, please list them.

1. [**10 points**] Problem set 3 Number 5. Demonstrate your function with the following input arguments:

```
ionodata.alpha0 = 1.1176e-008;
ionodata.alpha1 = 7.4506e-009;
ionodata.alpha2 = -5.9605e-008;
ionodata.alpha3 = -6.9605e-008;
ionodata.beta0 = 90112;
ionodata.beta1 = 0;
ionodata.beta2 = -296610;
ionodata.beta3 = -75536;
fc = 1575.42e6;
rRx = [-742005.851560607;
       -5462223.38476596;
       3198008.7346792];
rSv = [20847329.7083373;
       -15185642.4780402;
       6205281.68907901];
tGPS.week = 1575;
tGPS.seconds = 518201.501;
model = 'broadcast';
```

   Turn in your code for the function `getIonoDelay` and your result (`delTauG` in seconds to four significant digits). You do not have to turn in the subroutine for computing azimuth and elevation on which your function will rely.

2. [**10 points**] Problem set 4 Number 2, except that instead of analyzing the frequency plan of the GP2015, analyze the frequency plan in the figure shown at the end of the exam, which corresponds to the so-called Bobyn dual-frequency front end. You'll notice that this frequency plan only has one analog mixing stage before sampling. Trace the effect of mixing, filtering, and sampling on the L1 branch only (ignore the L2 branch). Calculate the final IF frequency of the GPS L1 signal after sampling. The L1 RF SAW filter (a bandpass filter) has a one-sided bandwidth of 20 MHz. The L1 IF SAW filter (also a bandpass filter) has a one-sided bandwidth of 2 MHz. The sampling rate of this front end is exactly the same as for the GP2015, namely,

$f_s = 40/7$ MHz. Note that the first mixing frequency is exactly $f_l = 49790/39$ MHz; the value given in the figure has been rounded. *Use the exact value in your calculations.* Note also that the frequency indicated under the L1 IF SAW filter is the approximate center frequency of the SAW filter, not that of the signal after mixing.

3. [**10 points**] Problem set 4 Number 5, except use the binary file

   `http://radionavlab.ae.utexas.edu/datastore/gnssSigProcCourse/niData03head_10MHz.bin`

   This file is of the same format as the file `niData01head.bin` that you used in the original problem, but the complex sampling rate is $f_s = 10$ MHz. Select an appropriate value for f_{IF}. Turn in your code for the functions `iq2if` and `if2iq` and plots for each of the three power spectra.

4. [**10 points**] Problem set 4 number 6.

5. [**20 points**] Problem set 4 number 8, except use data from the binary file

   `http://radionavlab.ae.utexas.edu/datastore/gnssSigProcCourse/dataout_raw_trimmed_158.bin`

   You can load samples correponding to a band centered at the GPS L1 frequency from this file into Matlab as follows:

```
fileName = 'dataout_raw_trimmed_158.bin';
fid = fopen(fileName,'r','l');
[yhist,count] = binloadSamples(fid,data_length,'dual');
yhist = yhist(:,1);
```

   You'll recall that you used `binloadSamples` to load data into Matlab back in Problem Set 2.

   The RF front-end used to capture these samples is the Bobyn front end mentioned above. Thus, you should know the sampling rate f_s and the intermediate frequency f_{IF} for these data.

   List the signals you find in increasing order of PRN. For the strongest signal present, turn in a plot of (1) $|S_k|$ vs. $\hat{f}_{D,k}$ for the maximizing $\hat{t}_{s,k}$, and (2) $|S_k|$ vs. $\hat{t}_{s,k}$ for the maximizing $\hat{f}_{D,k}$.

   Also hand in a copy of your code.

   There are 6 signals present in the data, 5 of which are above $C/N_0 = 39.5$ dB-Hz. You are not required to acquire the weakest signal, whose $C/N_0 \approx 36$ dB-Hz, but praise, glory, and one extra credit point will be yours if you do. Doppler due to the receiver clock's frequency offset is less than 1.1 kHz in magnitude. The receiver is mounted on the International Space Station with its antenna pointed in the anti-velocity direction so that it is moving (fast!) away from all trackable GPS satellites. Choose your Doppler window accordingly. The weakest signal is severely faded near the beginning of the data set; you may need to attempt its acquisition 80 ms or so into the data set.

6. [**10 points**] Problem set 5 number 4.

7. [**15 points**] Problem set 5 Number 6.

8. [**15 points**] Problem set 5 Number 8. Hand in a copy of your code.

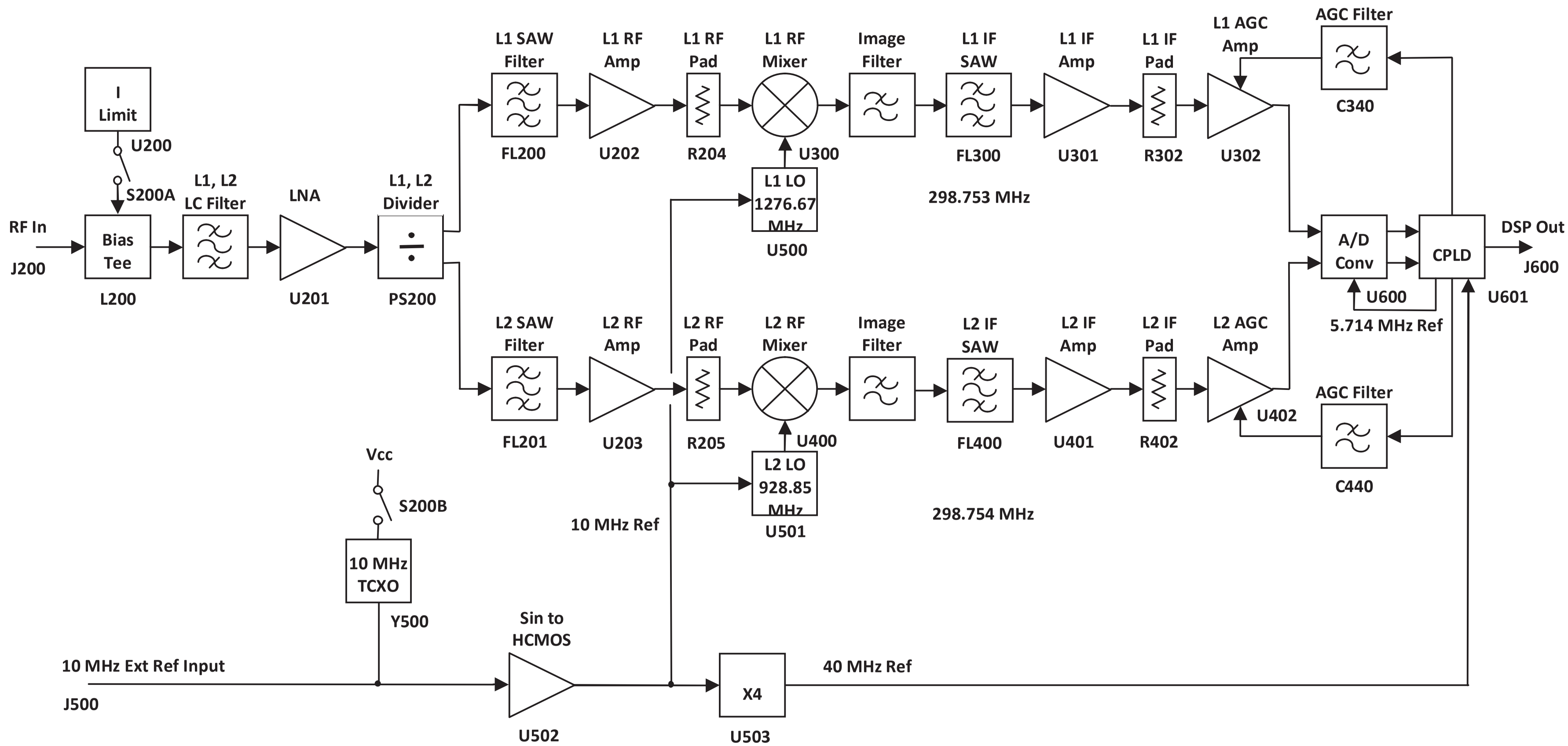

Figure 2 - L1/L2 GPS RF Front End - Block Diagram