## The L2C-Signal

A White House press release on March 30, 1998 announced that a civil signal would be added to the GPS L2 frequency. Following several years of discussions the design of the so called L2C code was finalised. In addition to describing some advantages and technical characteristics of the L2C signal, this newsletter presents an update of the launch schedule and investigates the true benefits of the civil signal on L2 for positioning and mapping.

## Advantages of L2C

Today all civil dual-frequency receivers use codeless or semi-codeless techniques to measure L2 without knowledge of the encrypted Y-code. Having knowledge of a code sequence on L2, would make L2 tracking less sophisticated. This would only be an advantage for the manufacturer, but invisible to the user.

From a user's point of view, the sole advantage of L2C is that it is just 2.3dB weaker than the L1 C/A code. Compared to codeless and semi-codeless techniques the L2 tracking with L2C will be marginally improved.

## Signal Structure and Supported Signals

The L2C signal contains two codes of different lengths. The CM code which is the moderate length code with a chip length of 10,230 chips, repeating every 20 milliseconds. This code is modulated with message data. The second code is the L2C long code (CL) with a length of 767,250 chips repeating every 1.5 seconds. The CL code has no data modulation. Like the L1 C/A code, the L2C code has an overall 1.023 MHz chip rate.

The modernized block IIR GPS satellites (IIR-M) will be the first satellites capable of transmitting L2C. Table 1 shows the new signal availability for upcoming GPS satellite generations.

| Signal/SV | IIR | IIR-M | IIF |
|---|---|---|---|
| L1 C/A | ✓ | ✓ | ✓ |
| L1 P/Y | ✓ | ✓ | ✓ |
| L2C | | ✓ | ✓ |
| L2 P/Y | ✓ | ✓ | ✓ |
| L5 | | | ✓ |

Table 1: New signal availability. Source: Fontana (2001)

## Launch Schedule

The 2003 launch schedule (last update September 2003) forecasts 2 more block IIR launches for this year. These satellites will not support L2C. The first launch of an IIR-M satellite is predicted to take place in the 4th quarter of 2004. According to the schedule of the US Air Force there will be 2 more IIR-M satellites launched in 2005 and 3 more in 2006.

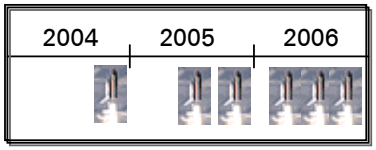


Table 2: IIR-M launch schedule. Source US Air Force (2003)

It has to be mentioned that in the past years a tendency has been observed that most planned launches have been delayed. Nevertheless, according to the presented, official schedule an initial operating constellation (IOC) of 12 satellites should be in place early 2009. The L2C FOC (full operating constellation) should be in place in the year 2012.

## True Benefits for Surveying

It is a fact that a usable constellation with L2C will not be in place before 2008/2009. The more exciting question therefore is, whether L2C will bring the user more value in terms of accuracy and availability.

- **Code Tracking Accuracy:** The effect of clock rate on code measurement accuracy is an important subject. L1 C/A and L2C have the same clock rate. It is assumed that an effective gated multipath mitigation correlator and the use of carrier aided code smoothing will deliver similar code accuracy as for L1 C/A. Due to a higher chip rate of the L2 P-code, the code accuracy of L2 P-code might even be better than the L2C-code – so no advantage gained here.

- **Availability:** The only conceivable benefit of L2C for surveying is a somewhat stronger signal on L2. In general, above 15-20° there is no difference in the number of observations between L1 C/A and L2 P-code. As already mentioned L1 C/A is 2.3 dB stronger than L2C, and there will be no difference in the number of received signals above 15-20° between L2 P and L2C. Extremely weak L2 signals might sometimes be tracked with the aid of L2C, while it would not be possible with the aid of L2 P.

Another decisive factor related to the tracking of weak signals is the tracking sensitivity of the receiver itself. Leica ClearTrack™ Technology guarantees optimized L2 tracking, true multipath mitigation and jamming resistance.

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A test was undertaken where the signal of a Dorne Margolin Choke Ring antenna was split to an SR530 and a Trimble 5700. Careful attention was paid to set the appropriate receiver gain for each GPS receiver. Table 3 shows a comparison of tracked observations of low elevation satellites (< 30) between Leica and Trimble relative to Leica.

| Signal \ #Obs. | SR530 | T5700 |
|---|---|---|
| L1 C/A low SV | 100% | 75% |
| L2 P low SV | 100% | 91% |

Table 3: Comparison SR530 – T5700

## Remember…

- It is a fact that a usable constellation with L2C will not be in place before 2008/2009.
- The only marginal benefit for surveying might be the possibility of tracking extremely weak L2 signals.
- No improvement in measurement accuracy or reliability.

## References

Fontana, R.,D., Cheung, W., Stansell, T. (2001) 'The modernized L2 Civil Signal', GPS World, September 2001

US Air Force (2003) 'GPS Program Update', http://www.fs.fed.us/database/gps/steering_group/gps_modernization.pdf

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