Understanding Compass Codes

Grace Xinxin Gao*, Alan Chen, Sherman Lo, David De Lorenzo, Todd Walter and Per Enge
Stanford University, Stanford, CA

Introduction
With the launch of its first middle-earth-orbiting (MEO) Compass satellite, China has put forth its GNSS entity. The key to using and understanding the performance of the Compass M-1 navigation signals is revealed by its spread spectrum code. This poster presents the spread spectrum codes being broadcast by this satellite.

What is Compass, why seek Compass codes?
- Beidou II: Compass
  - Global positioning
  - MEO satellites
  - One way communication
  - On launch, China announced that from 2008 Beidou would offer ommunic with an accuracy of 15 meters.
    - The first MEO satellite, Compass M1 was launched on April 14, 2007
    - More than 20 satellites in operation. (GPS: 24, Beidou: 24, Galileo: 24,222 km)
  - Current plan: 35 satellites – 30 MEO – 5 GEO
- Compass provides additional 35 satellites to the GPS/Galileo system
  - More accuracy and integrity
- Compass E2/E6/E5 bands overlap with Galileo E2/E5b bands and GPS L1 band
  - Can use the same antenna for the integrated Compass/Galileo/GPS receivers
  - Interoperability; Interference to Galileo/GPS
- New GPS signals
  - We are considering designing new signals from GPS and terrestrial ranging sources that could augment GPS. Thus, we are eager to gain a deep understanding of the recent efforts by our European colleagues.

Data Collection
- L-band: Carrier + 10 bits
- High-gain dish 1.8 meter steerable
- High-gain directional feed

Decoding Process

1. Determining Code Period: 1 ms
2. Initial Phase Adjustments
3. Doppler Wipeoff
4. Initial Code Chips

Deriving Code Generators

1. Start with linear codes
   - Linear codes can be generated by linear shift register (LSR)
2. Linear Shift Register

3. Determining the start of the code and shifting of whole data

Code Generators Obtained
E2/E6/E5b codes are identical
Obtain code generator polynomials
- L-band: 19
- The code is generated by a 20-bit polynomial
- The obtained code generator polynomials can be factorized
- Ambiguity of +10 bits removed
- The secondary code is generated by modulo-2 adding maximal length sequence of the factor polynomials = Gold codes!
- Secondary code: 20 bits = Neuman-Hoffman code

Conclusion
The Compass broadcast code in E2/E6/E5b bands are decoded. The code sequences are revealed, and the codes proved to be Gold Codes. We derived the code generators as well. The E2/E6/E5b codes are generated by 11 stage Linear Shift Feedback Register (LSFR), while the E6 code is generated by 13 stage LSFR.

References
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