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# Evaluation of QZS-1 LEX Signal


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# Background of QZSS

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- *Regional space-based PNT system*
- *Coverage: East Asia and Oceania region*
- *6 Signals (QZS-1):*
  - ✓ *L1C/A, L1C, L2C and L5*
    - *–can provide seamless PNT services by combining usage with GPS.*
    - *–Increasing coverage and availability of PNT services even in downtown and mountainous areas.*
  - ✓ *L1-SAIF on 1575.42 MHz*
  - ✓ *LEX on 1278.75MHz*
- *Accelerate: the modernization of GPS in Asia Oceania region.*
- *Platform: for Multi-GNSS augmentation.*
- *First satellite: QZS-1 called "MICHIBIKI" was launched in September 11, 2010.*

# QZS-1 Signals

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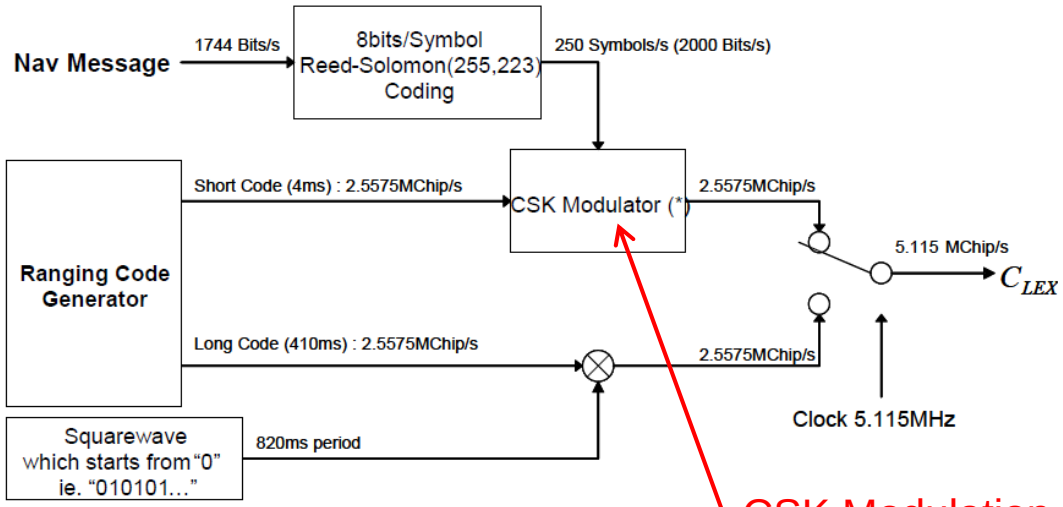
| | Frequency | Notes |
|---|---|---|
| L1-C/A | 1575.42MHz | ➢ Fully compatibility and interoperability with existing and future modernized GPS signals<br>➢ Integrity flag, Ionospheric correction<br>➢ Almanac & Health for other GNSS SVs |
| L1C | | |
| L2C | 1227.6MHz | |
| L5 | 1176.45MHz | |
| L1-SAIF* | 1575.42MHz | ➢ Compatibility with GPS-SBAS (250bps) |
| LEX | 1278.75MHz | ➢ Higher data rate message (2Kbps) for PPP, RTK<br>➢ Compatibility & interoperability with Galileo E6 CS signal |

* L1-SAIF: L1-Submeter-class Augmentation with Integrity Function

# LEX Signal (1/2)



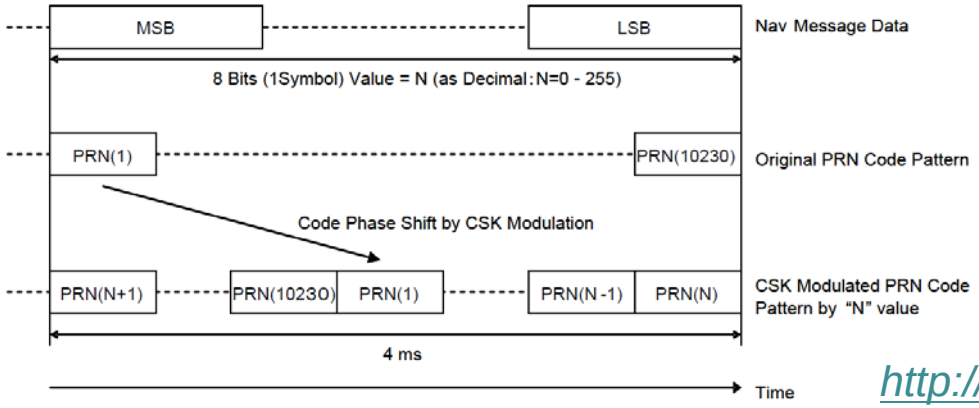
## Signal Structure




CSK Modulation is used.

- 8 bits / symbol
- Data rate: 250 symbols/sec (2000 bits/sec)
- 1 Frame = 250 symbols = 2000 bits

(*) **Definition of Code shift Keying (CSK) Modulation**



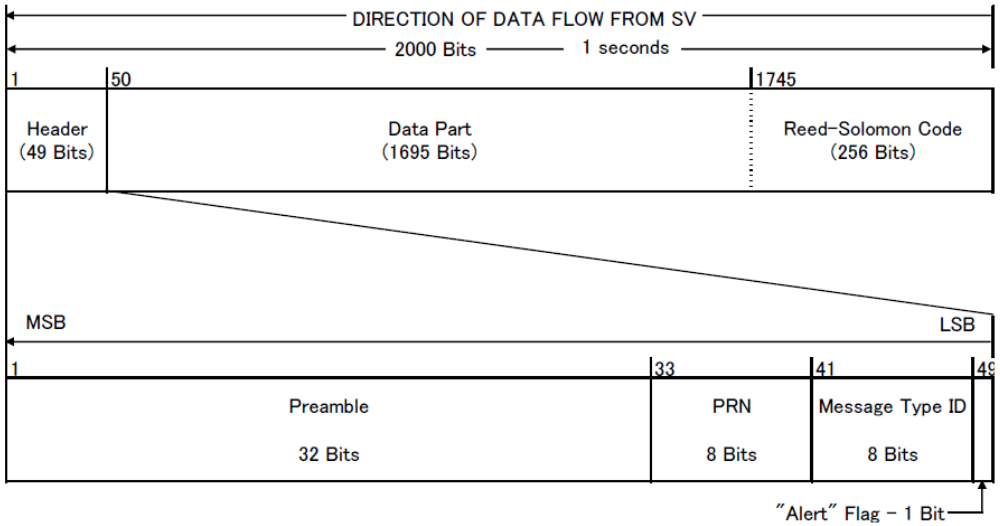

Details of LEX signal is described in IS-QZSS.
Google "IS-QZSS", or visit following site.

http://qz-vision.jaxa.jp/USE/is-qzss/index_e.html

# LEX Signal (2/2)



LEX Message Structure



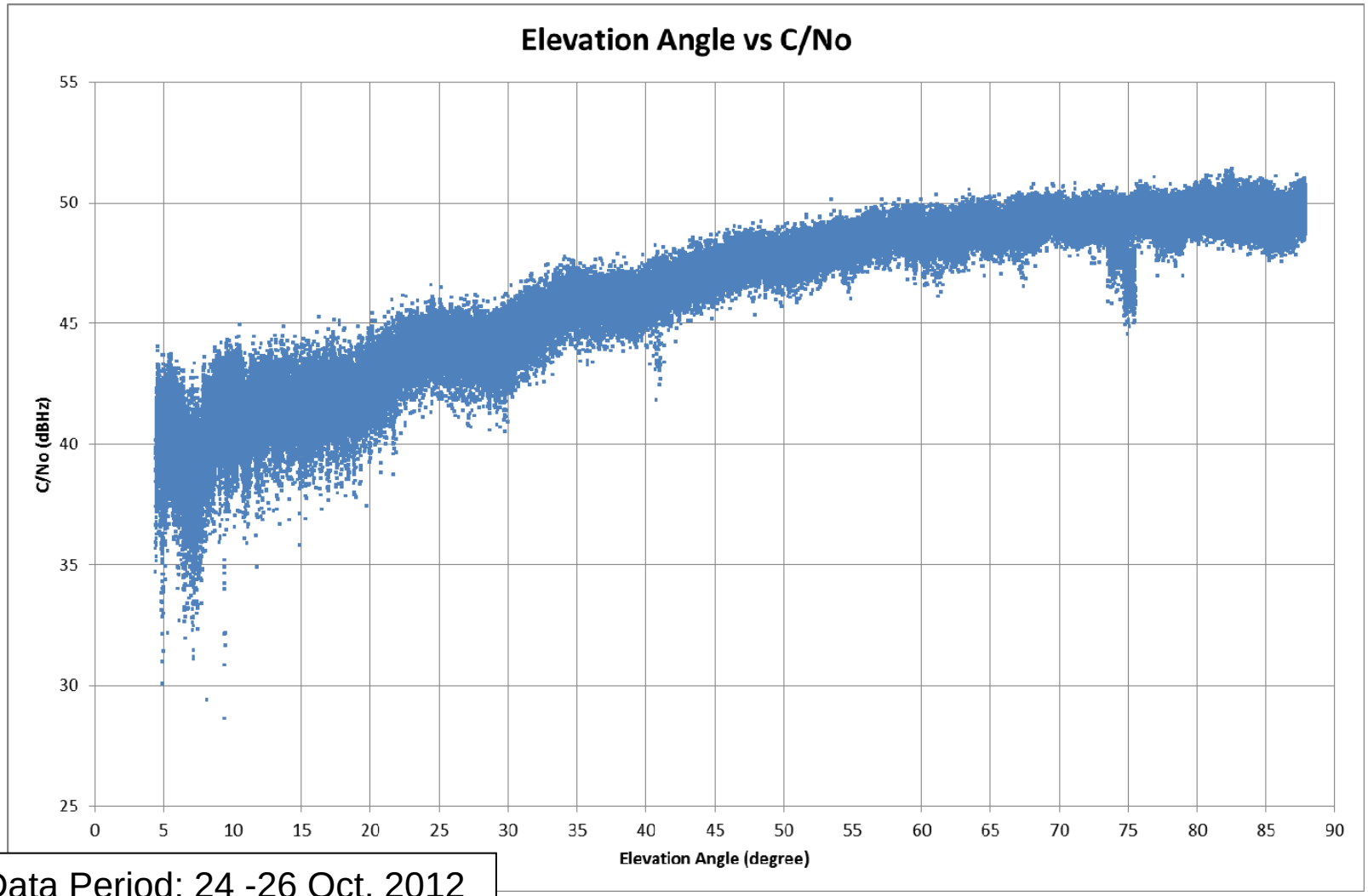

- 1695 bits as Data Part
- Reed-Solomon (256 bits = 16 symbols)

-> Error Correction: up to 16 symbols.
Miss-decode more than 16 symbols
results in Frame Error.

We evaluated followings;
1.Frame Error v.s. Elevation Angle
2.Theoritical v.s. Experimental
Frame Error Rate (FER).

# Evaluation Data

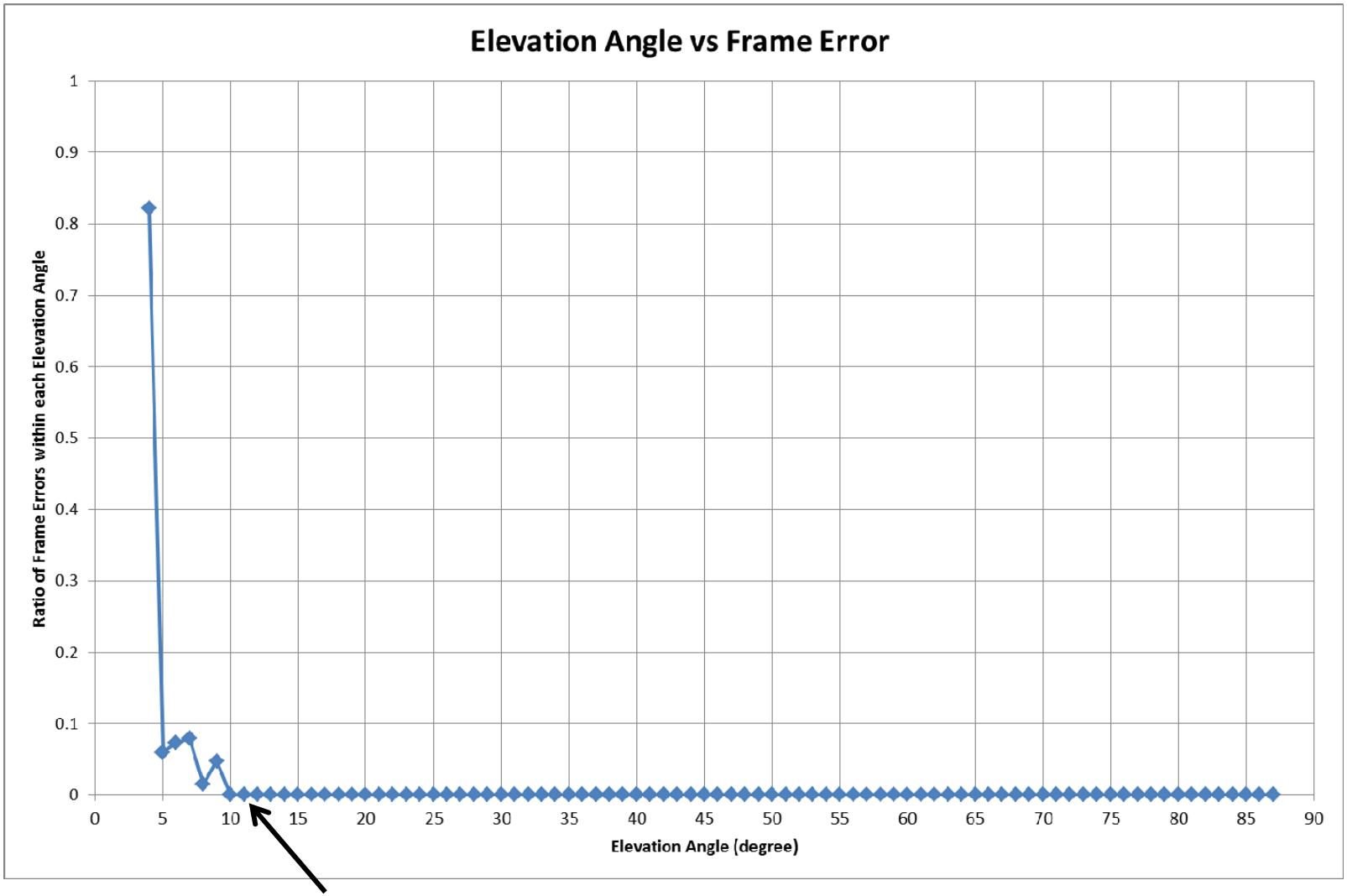





- Data Period: 24 -26 Oct, 2012
- Received at Tokyo in Japan

# Evaluation Results (1/2)
# - Elevation Angle v.s. Frame Error -

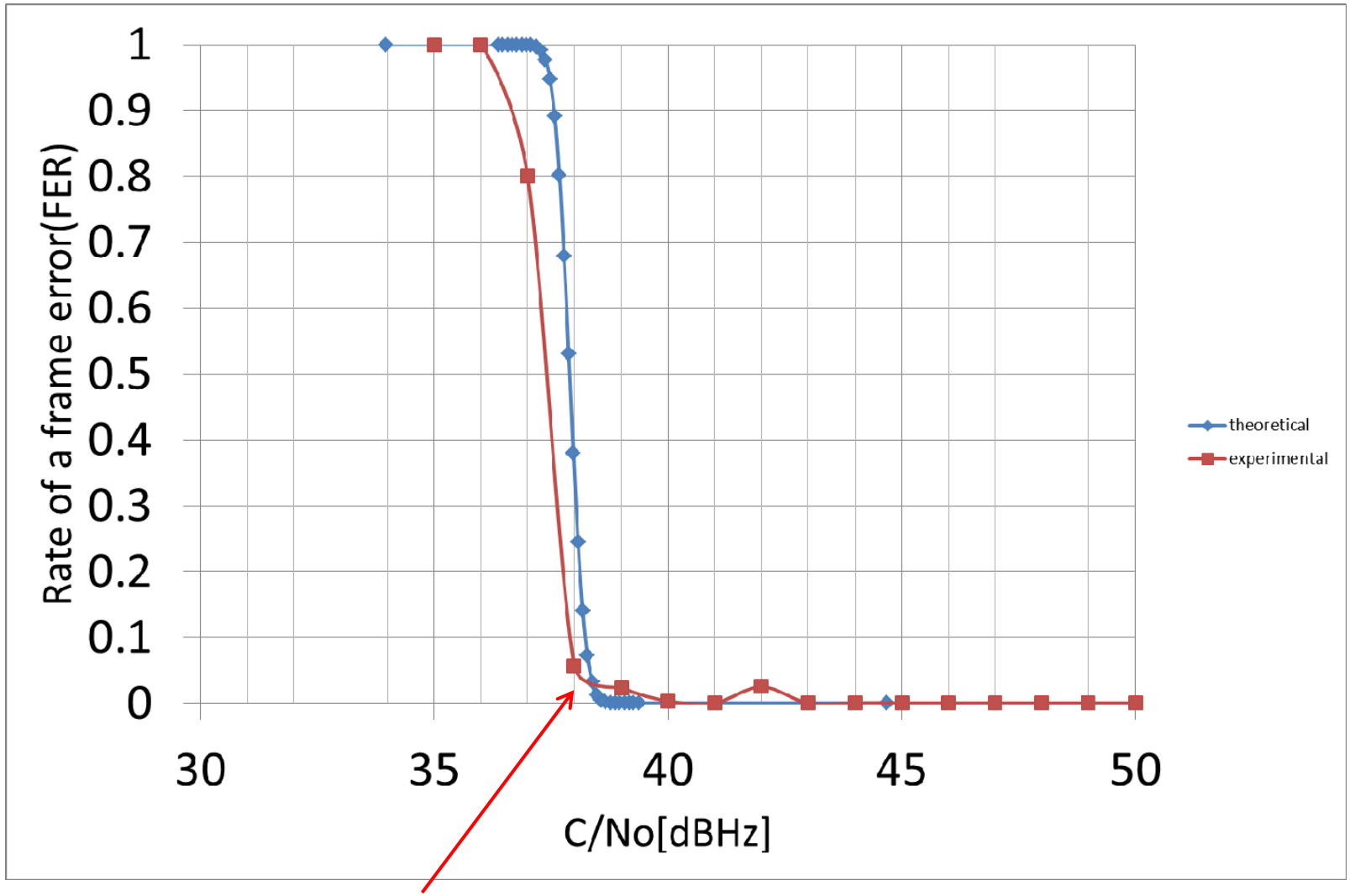





Signals at more than 10 degrees of elevation angle, No Frame Error.

# Evaluation Results (2/2)
# - Theoritical FER v.s. Experimental FER -






Theoritical Frame Error Rate (FER) v.s. Experimental FER is almost same.

# Conclusion



- QZS-1 called “MICHIBIKI” transmits LEX signal which has high data rate (2 kbps), and the CSK (Code Shift Keying) modulation is used.
- We evaluated followings;
  - Elevation angle v.s. Frame Error
  - Theoritical FER v.s. Experimental FER
- Experimental results showed that we could receive LEX signal with No FER at more than 10 degrees.
- The results of theoritical FER and experimental FER showed almost same.
- These results proved that our signal design and the CSK modulation for higher data rate are not bad.