GNSS Signals, Spectra, and Receiver Fundamentals

Disclaimer

The views and opinions expressed herein do not necessarily reflect the official policy or position of any government agency

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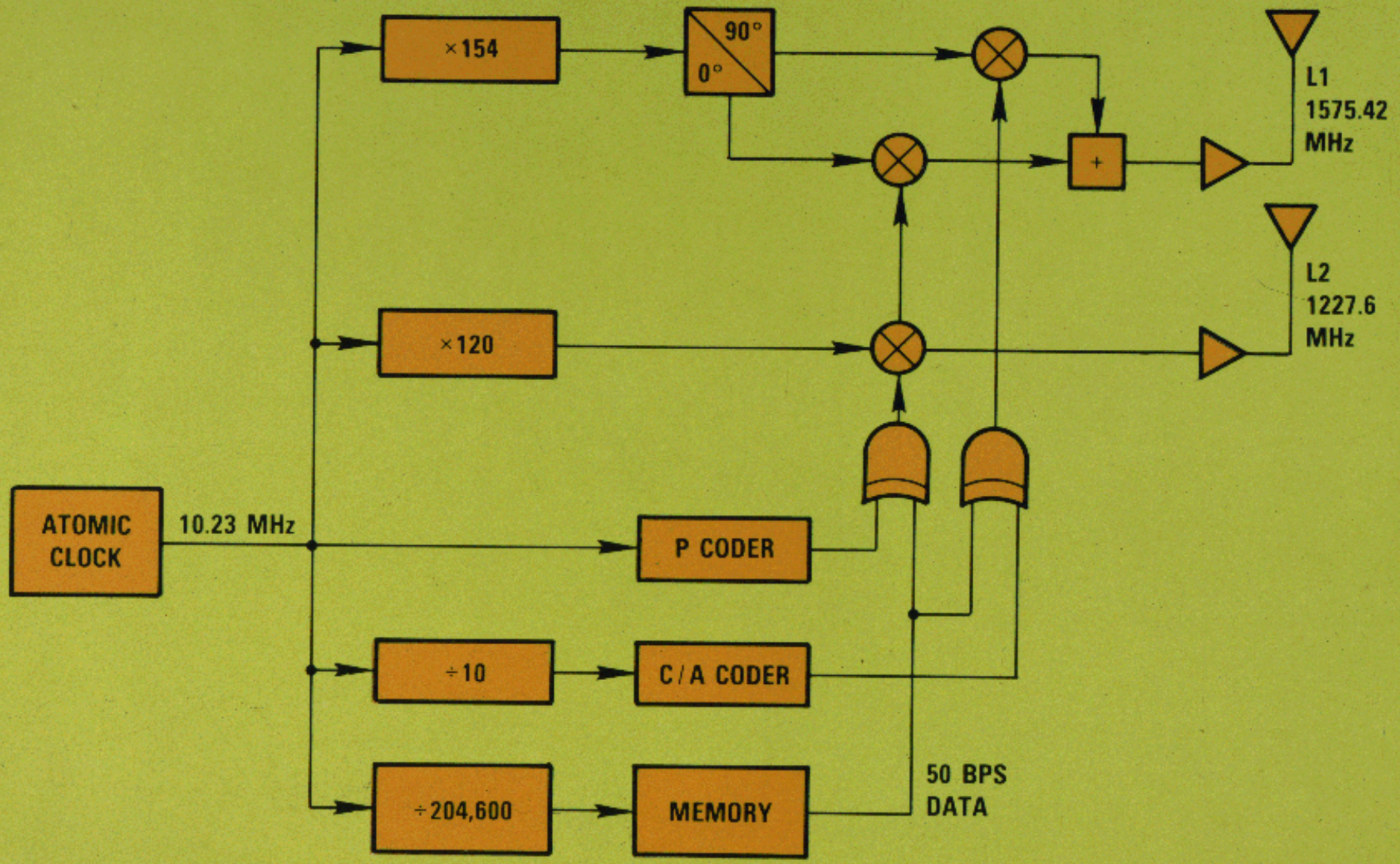
SIMPLIFIED GPS SATELLITE BLOCK DIAGRAM



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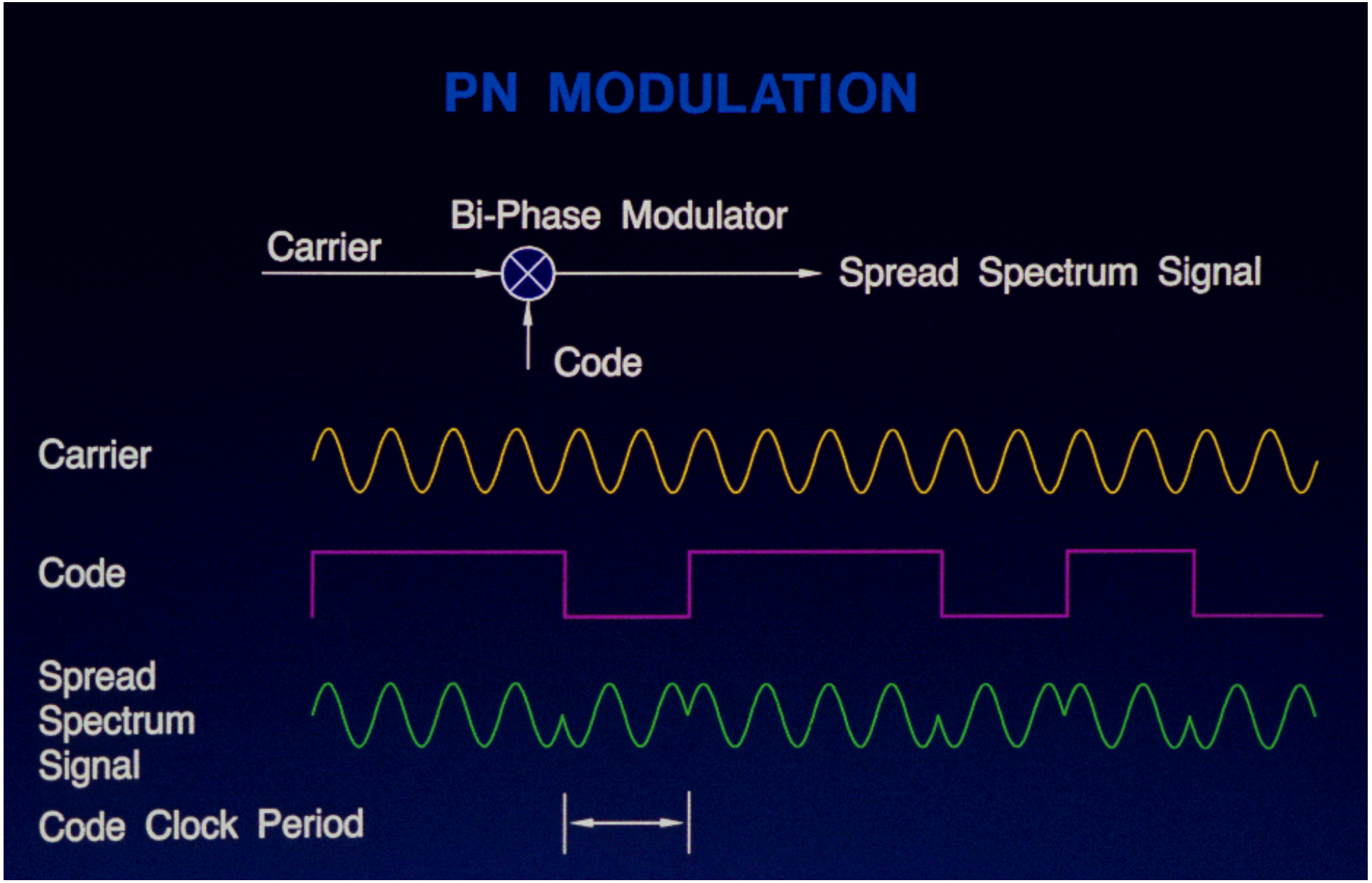
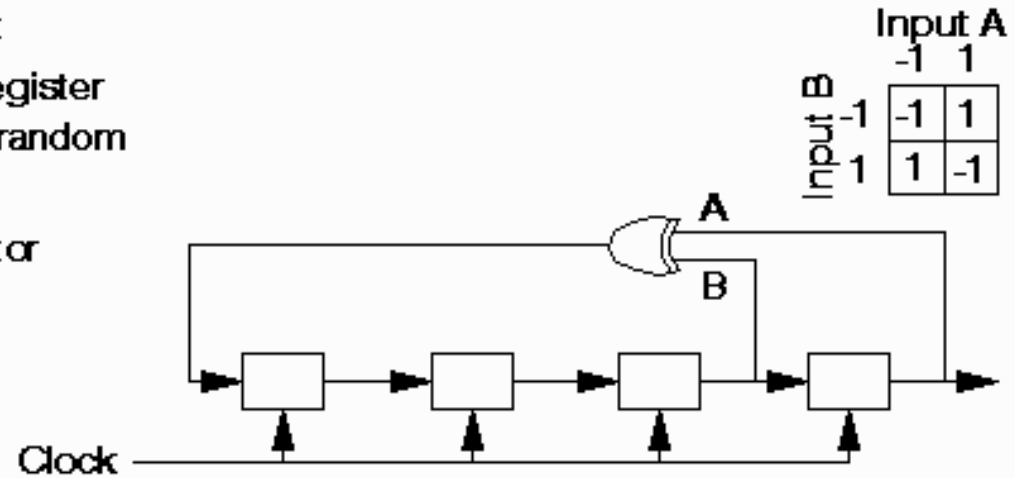

PN MODULATION
Bi-Phase Modulator
Carrier
Spread Spectrum Signal
Code
Carrier
Code
Spread
Spectrum
Signal
Code Clock Period

Simple Pseudorandom Code Generator

Four Bit
Shift Register
Pseudorandom
Code
Generator

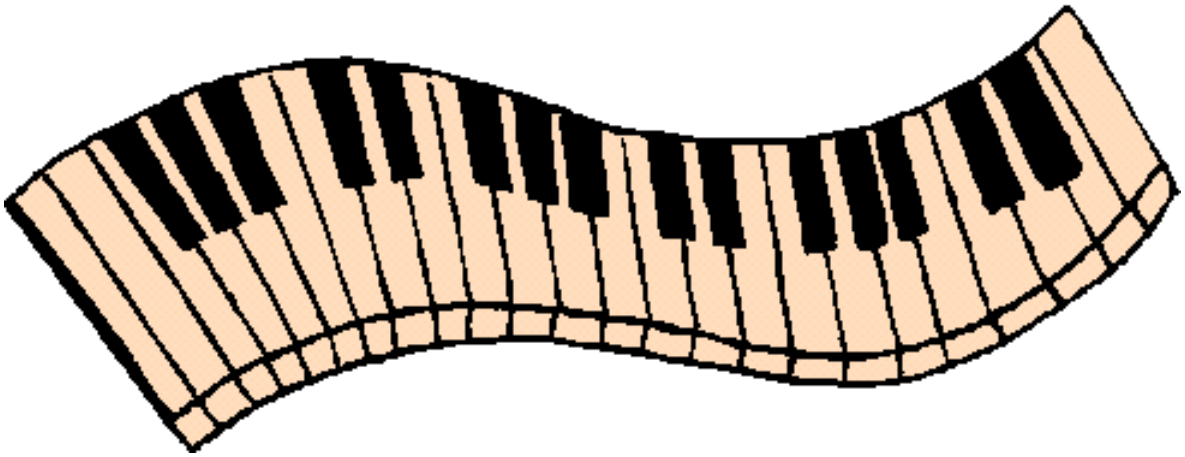


1	1	1	1
-1	1	1	1
-1	-1	1	1
-1	-1	-1	1
1	-1	-1	-1
-1	1	-1	-1
-1	-1	1	-1
1	-1	-1	1
1	1	-1	-1
-1	1	1	-1
1	-1	1	1
-1	1	-1	1
1	-1	1	-1
1	1	-1	1
1	1	1	-1
1	1	1	1

Code length = $(2^N - 1)$ = $(2^4 - 1) = 15$

C/A Code length = $(2^N - 1)$ = $(2^{10} - 1) = 1023$

Code Modulation Spreads the Spectrum



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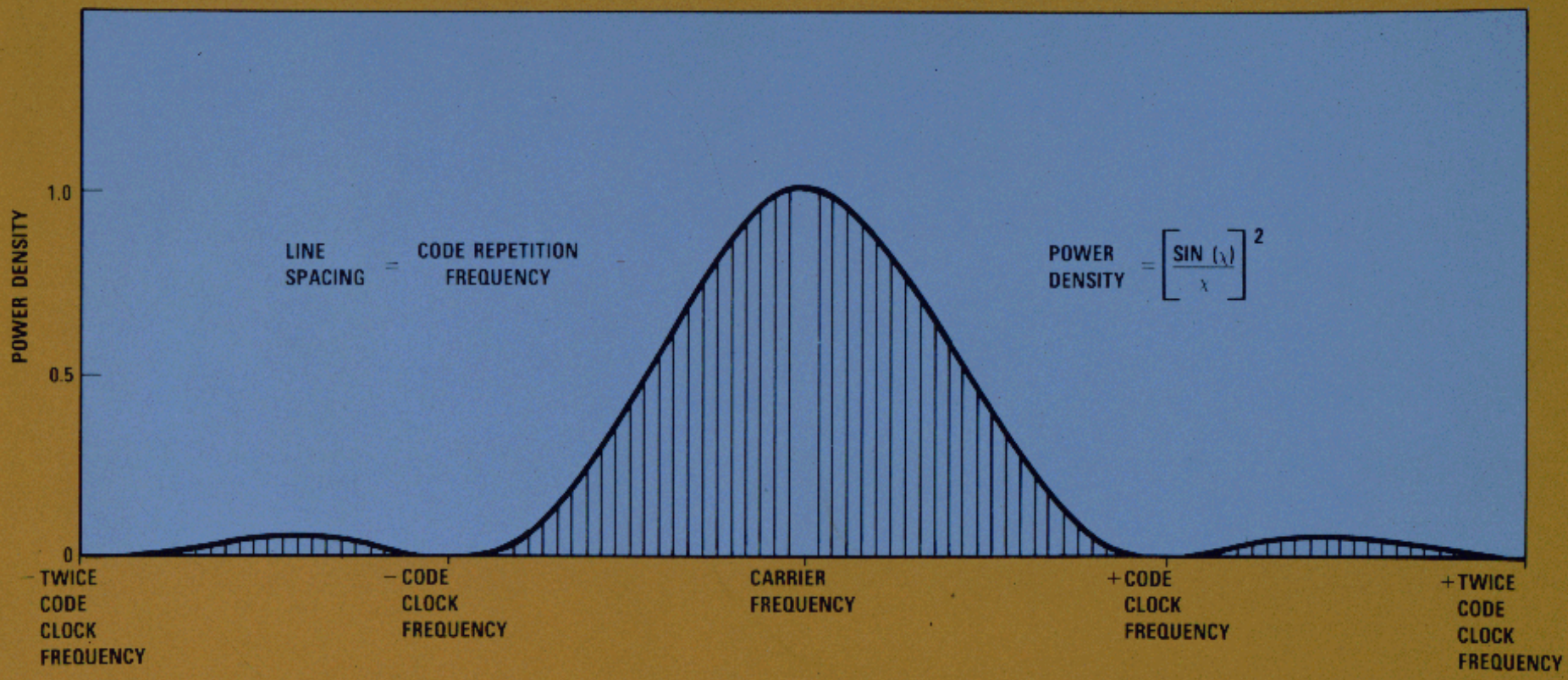
SPREAD SPECTRUM POWER DENSITY



Frequency Domain

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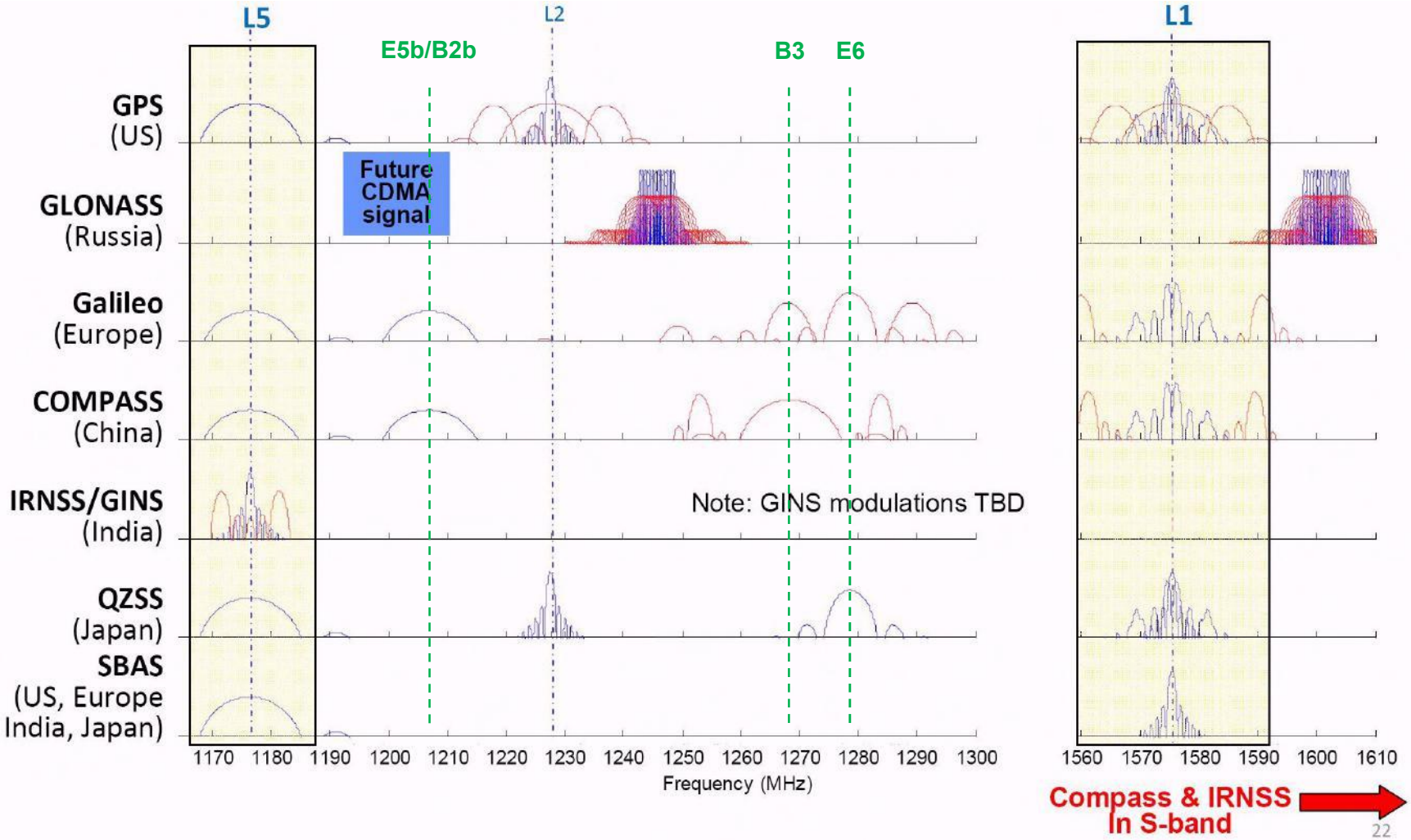
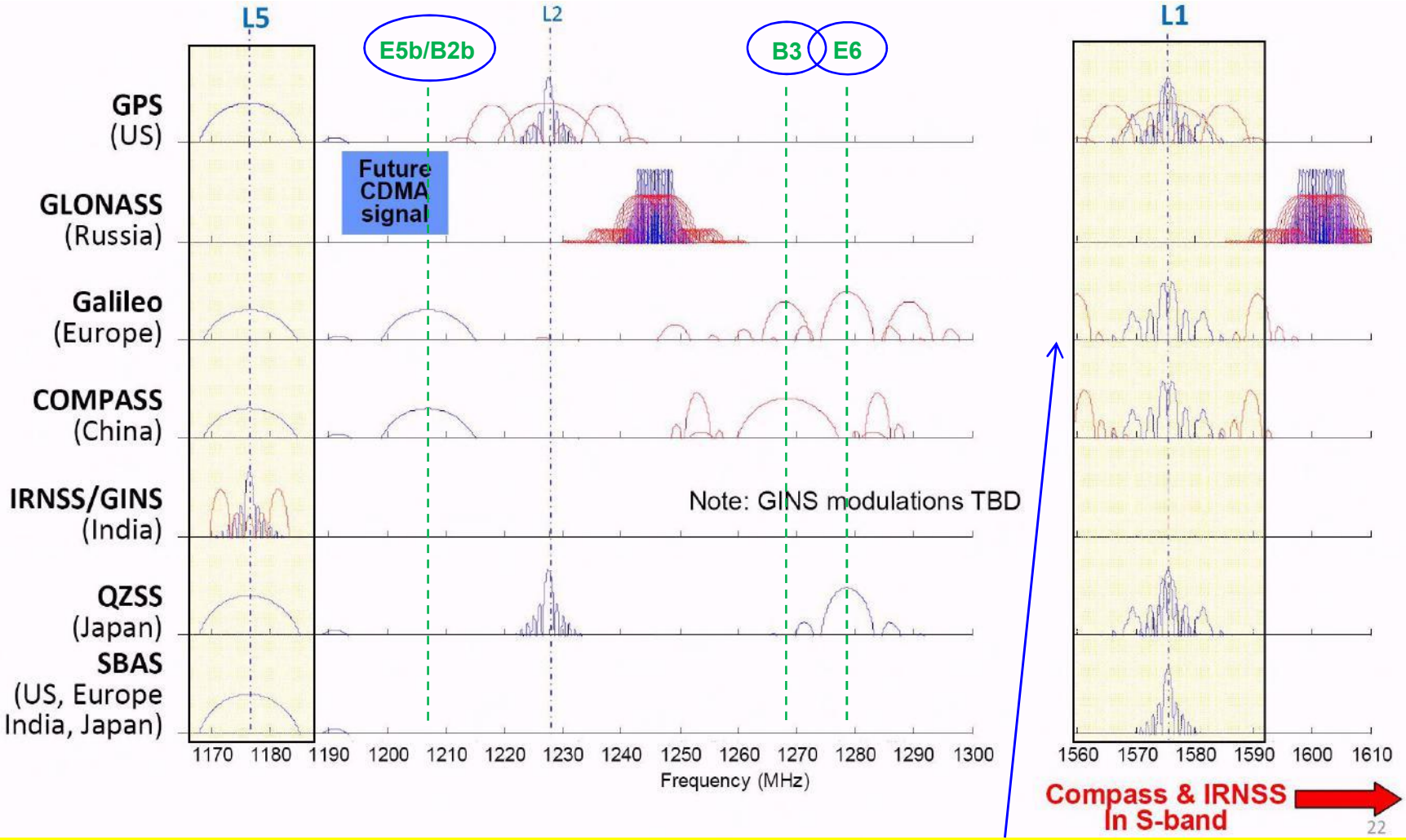
GNSS Spectra To Protect



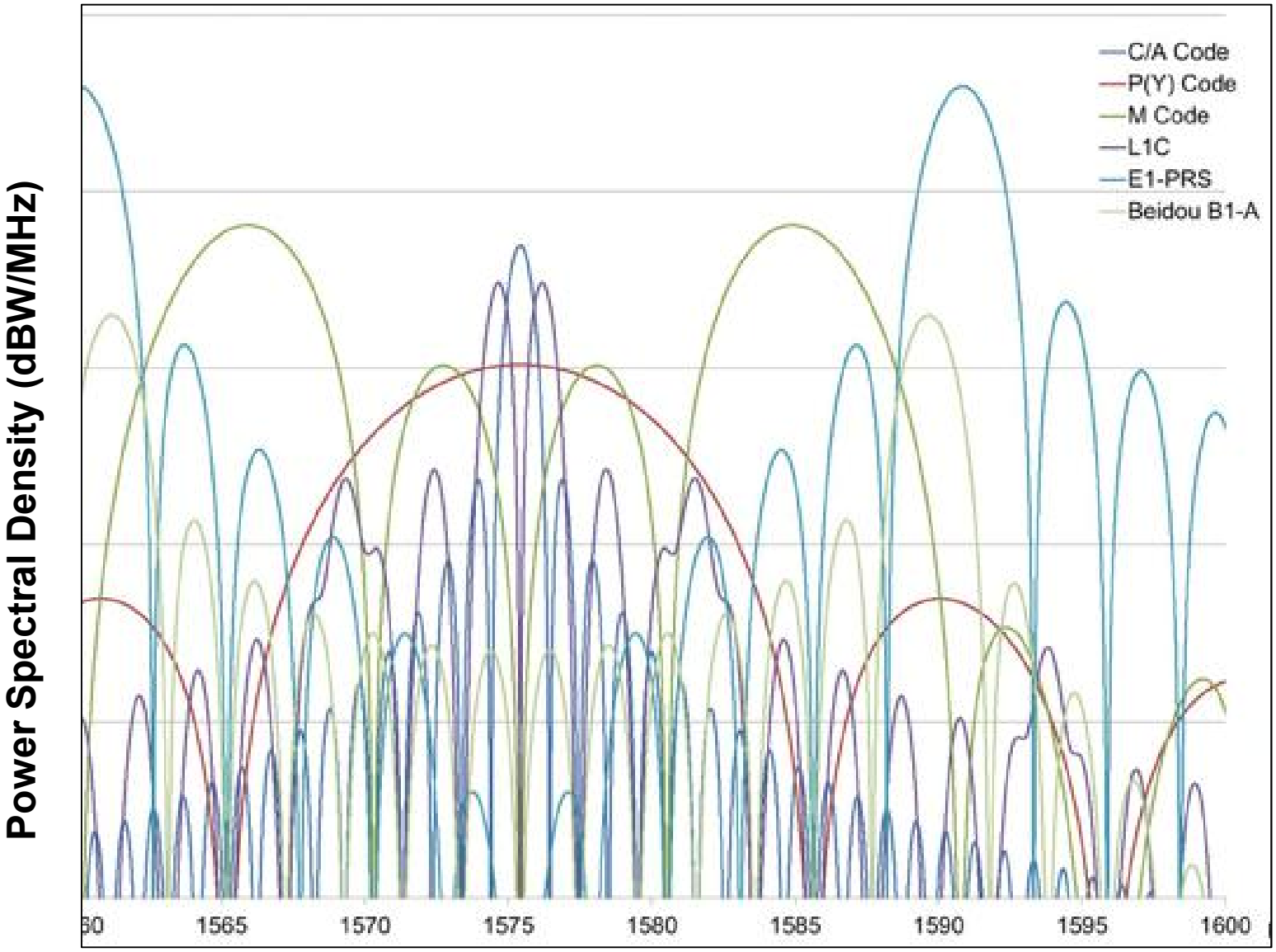
L1, L2, & L5 are paramount, but also GLONASS, PRS, E5b, B3, & E6

GNSS Spectra To Protect

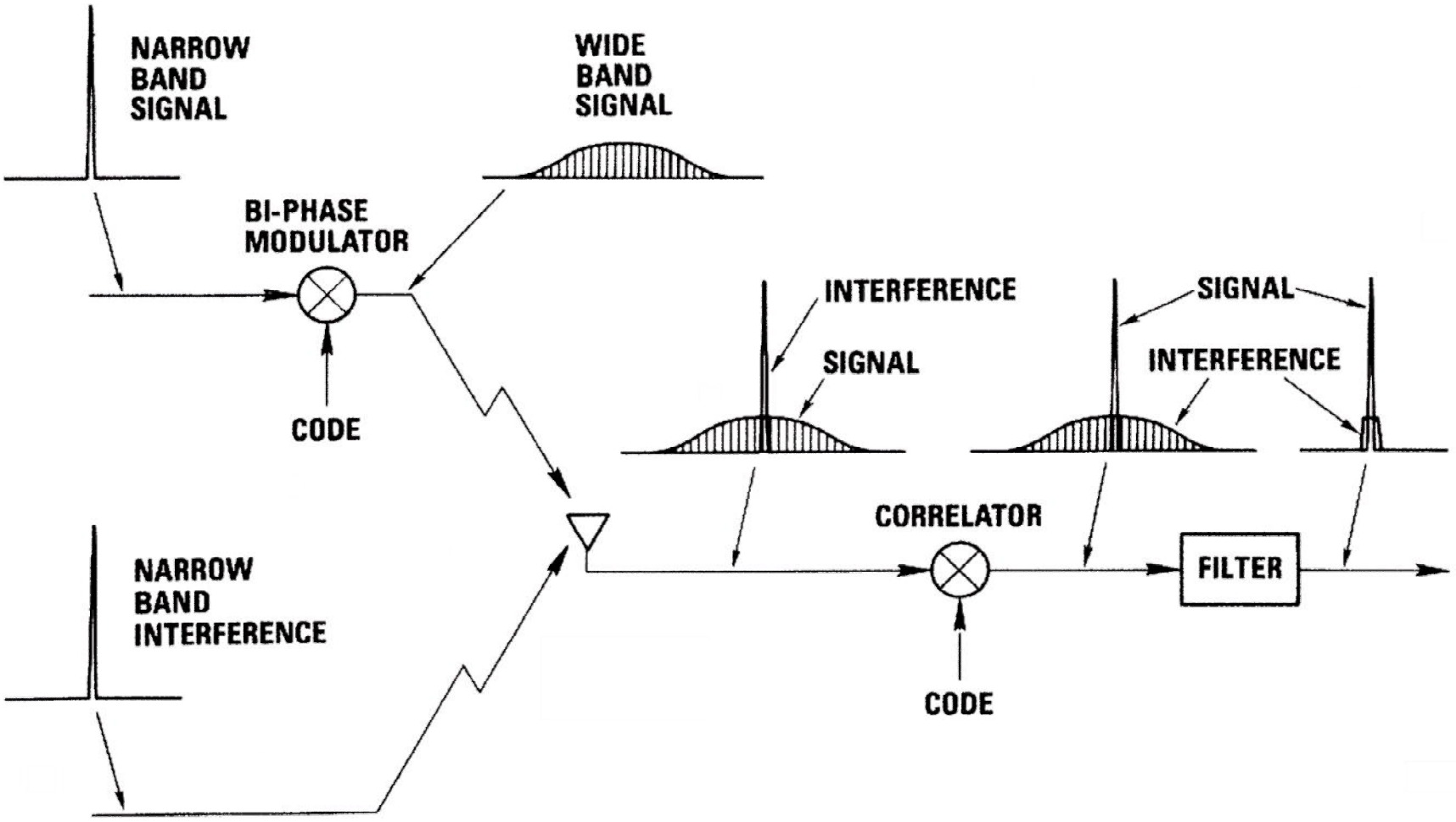


L1, L2, & L5 are paramount, but also GLONASS, PRS, E5b, B3, & E6

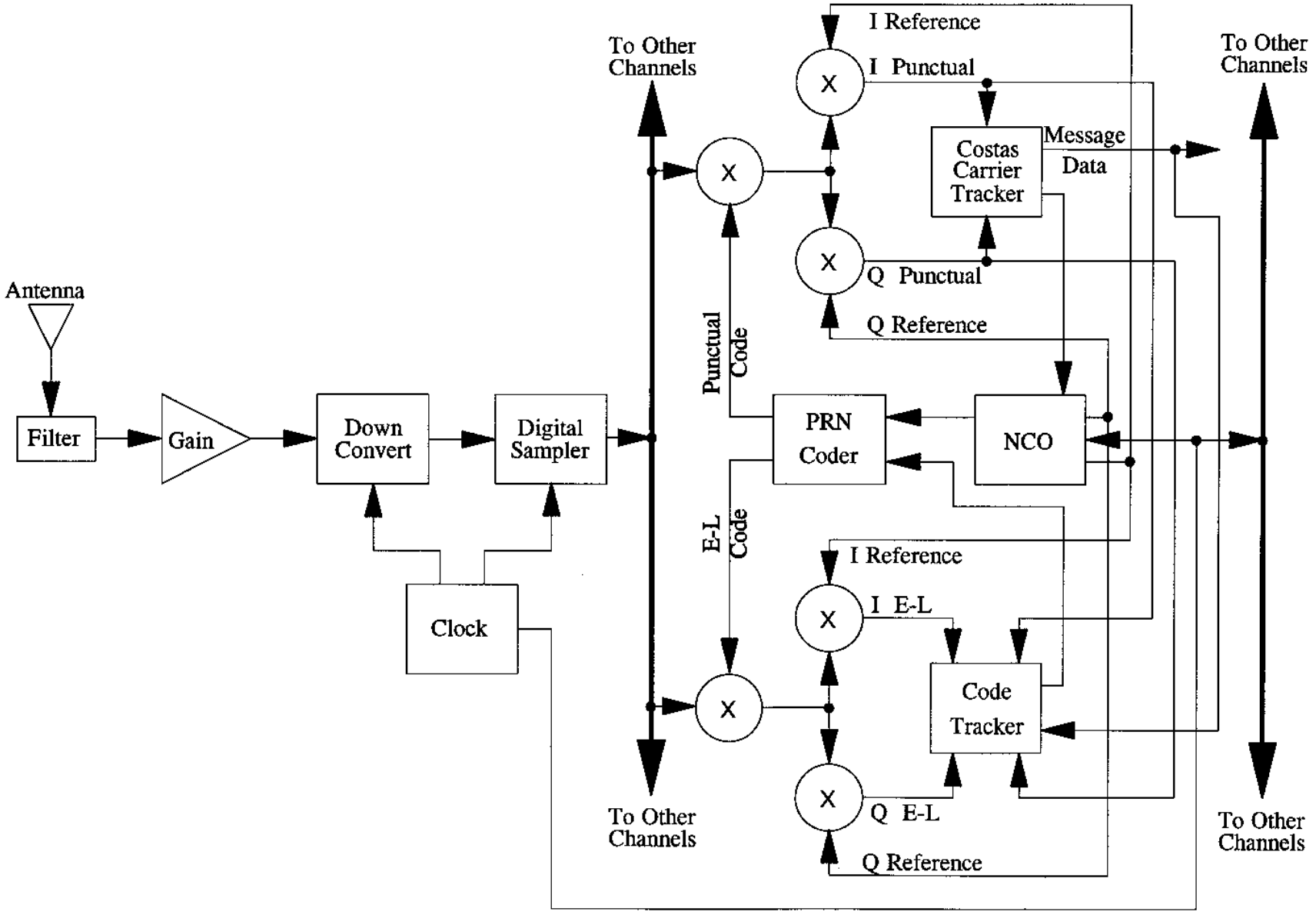
GNSS L1 Spectrum



Receiver Signal Processing



Multi-Channel Digital Receiver



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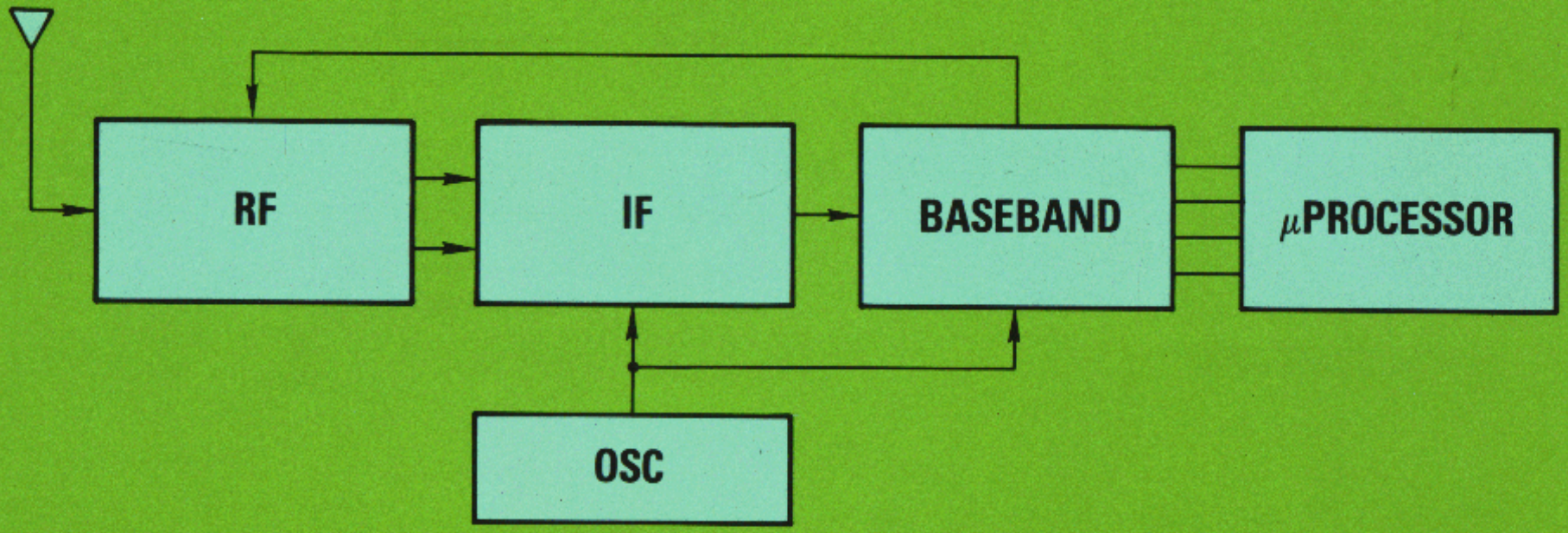
CORE GPS CHIP SET



388-680

27 Years with Just 3 GPS Signals

Signal/SV	IIR
L1 C/A	✔
L1 P(Y)	✔
L1 M	
L1C	
L2 P(Y)	✔
L2C	
L2 M	
L5	

Direct civil access to C/A code

Indirect civil access by codeless and semi-codeless means

1978 to 2005

IIR-M Satellites Add Three More

Signal/SV	IIR	IIR-M
L1 C/A	✓	✓
L1 P(Y)	✓	✓
L1 M		✓
L1C		
L2 P(Y)	✓	✓
L2C		✓
L2 M		✓
L5		

Direct civil access to L2C code

1978 to 2005

2005

IIF Satellites Add L5

Signal/SV	IIR	IIR-M	IIF
L1 C/A	✓	✓	✓
L1 P(Y)	✓	✓	✓
L1 M		✓	✓
L1C			
L2 P(Y)	✓	✓	✓
L2C		✓	✓
L2 M		✓	✓
L5			✓

Safety service in ARNS band

1978 to 2005 | **2005** | **2010**

GPS III Will Add L1C

Signal/SV	IIR	IIR-M	IIF	III
L1 C/A	✓	✓	✓	✓
L1 P(Y)	✓	✓	✓	✓
L1 M		✓	✓	✓
L1C	Better performance			✓
L2 P(Y)	✓	✓	✓	✓
L2C		✓	✓	✓
L2 M		✓	✓	✓
L5			✓	✓
	1978 to 2005	**2005**	**2010**	**2017?**

Modernized Signal Structures

- The most important improvements in GNSS signal structures since1978 have been adopted for essentially every new and modernized signal
  - Including GPS, Galileo, BeiDou, and QZSS
  - Hopefully also for IRNSS and GLONASS CDMA
- The improvements are (a) to have a data-less pilot carrier and (b) to use Forward Error Control (FEC) to enhance data reception
- There are many other variations, e.g.,
  - Binary Offset Carrier (BOC) combinations, spreading code structures, FEC techniques, power split between data and pilot channels, symbol interleaving, etc.
  - Each has a purpose, e.g., spectrum separation

Thank You

Questions?