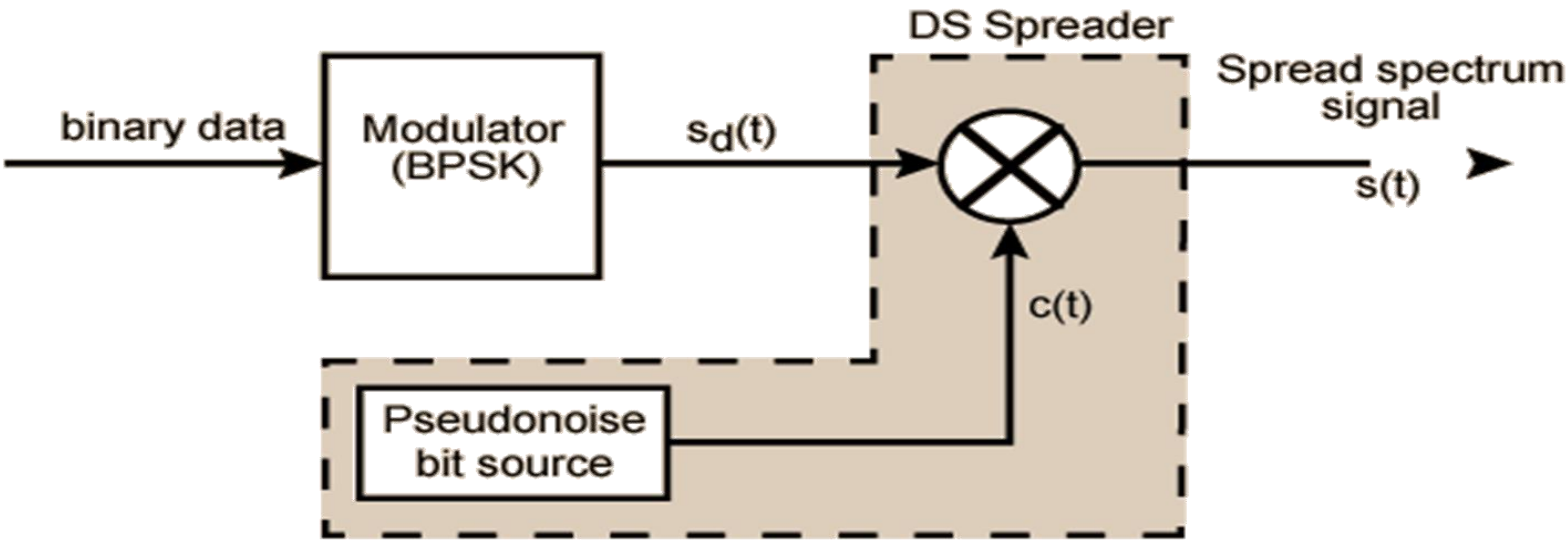
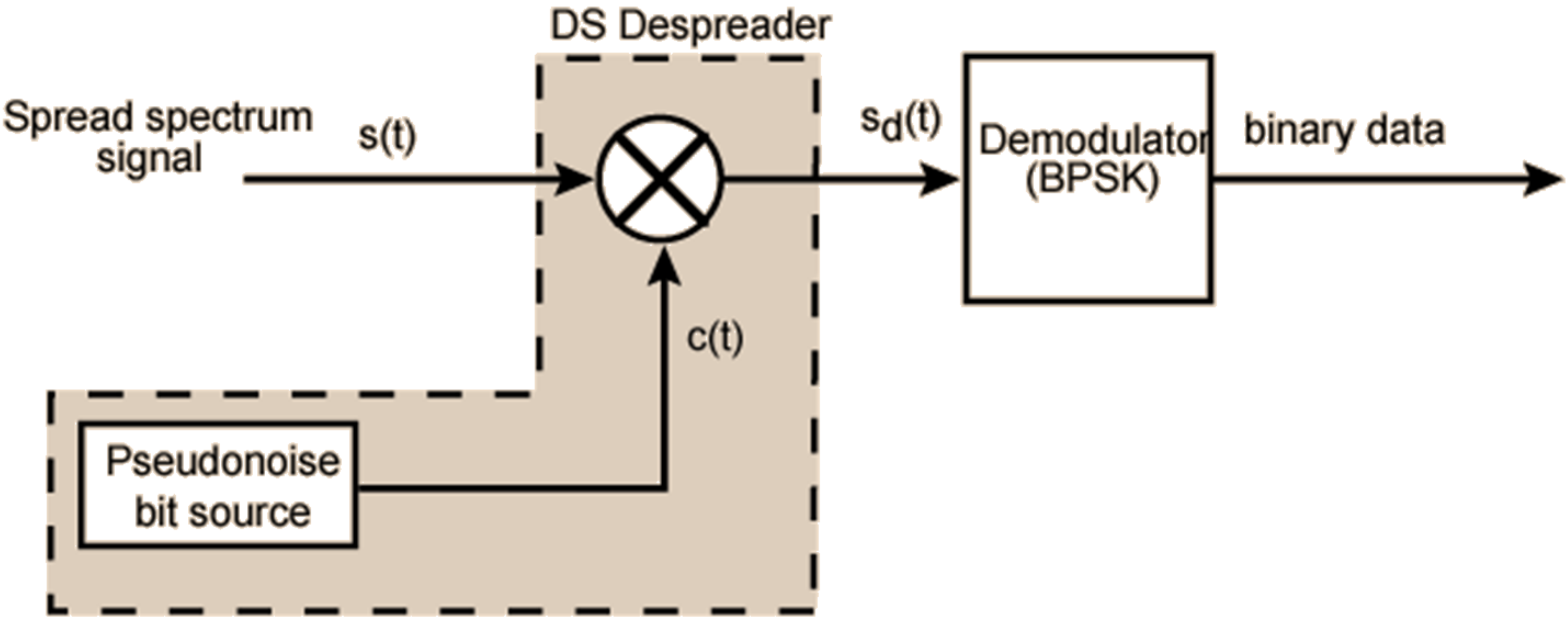
Direct Sequence-Spread Spectrum Sequence

Direct Sequence



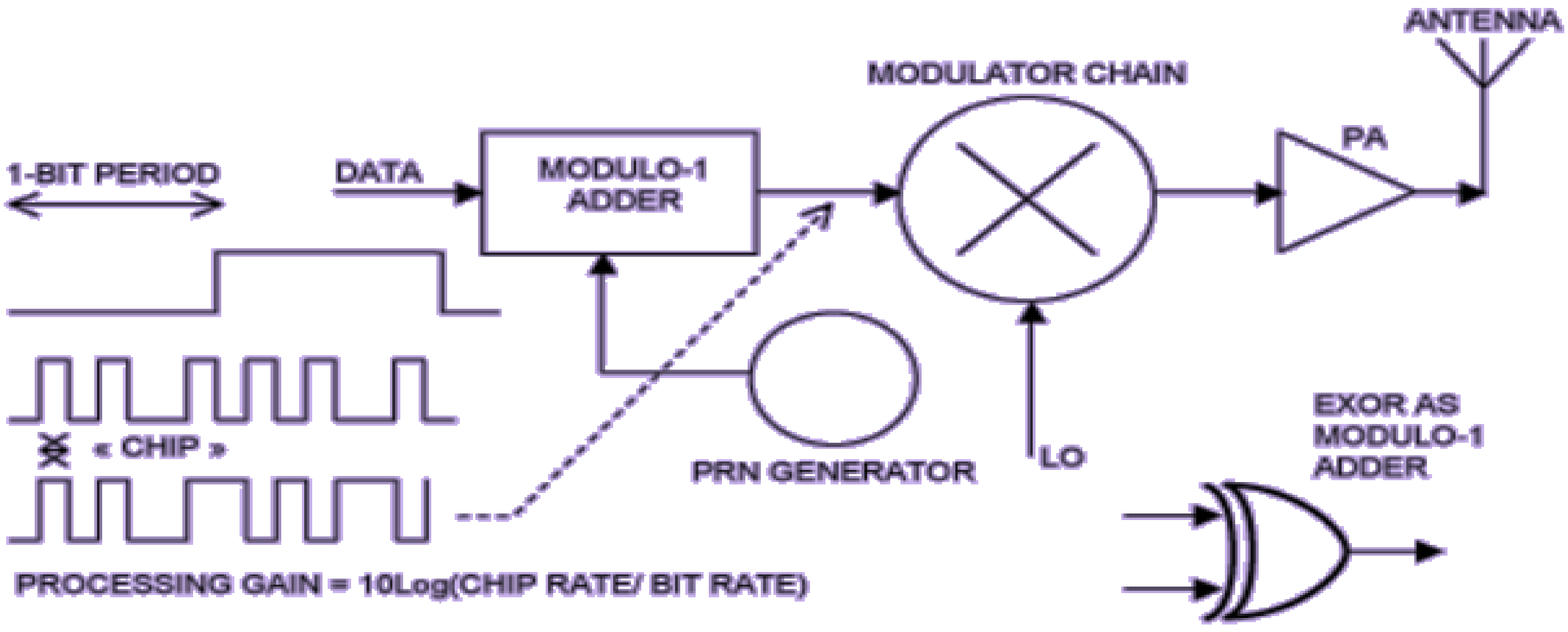
- Mixer or balanced modulator as biphase modulator.
- Phase modulation since
  - ✓ Constant envelope
  - ✓ more power to transmit information
  - ✓ suppressed carrier signal make the detection not easy

Receiver

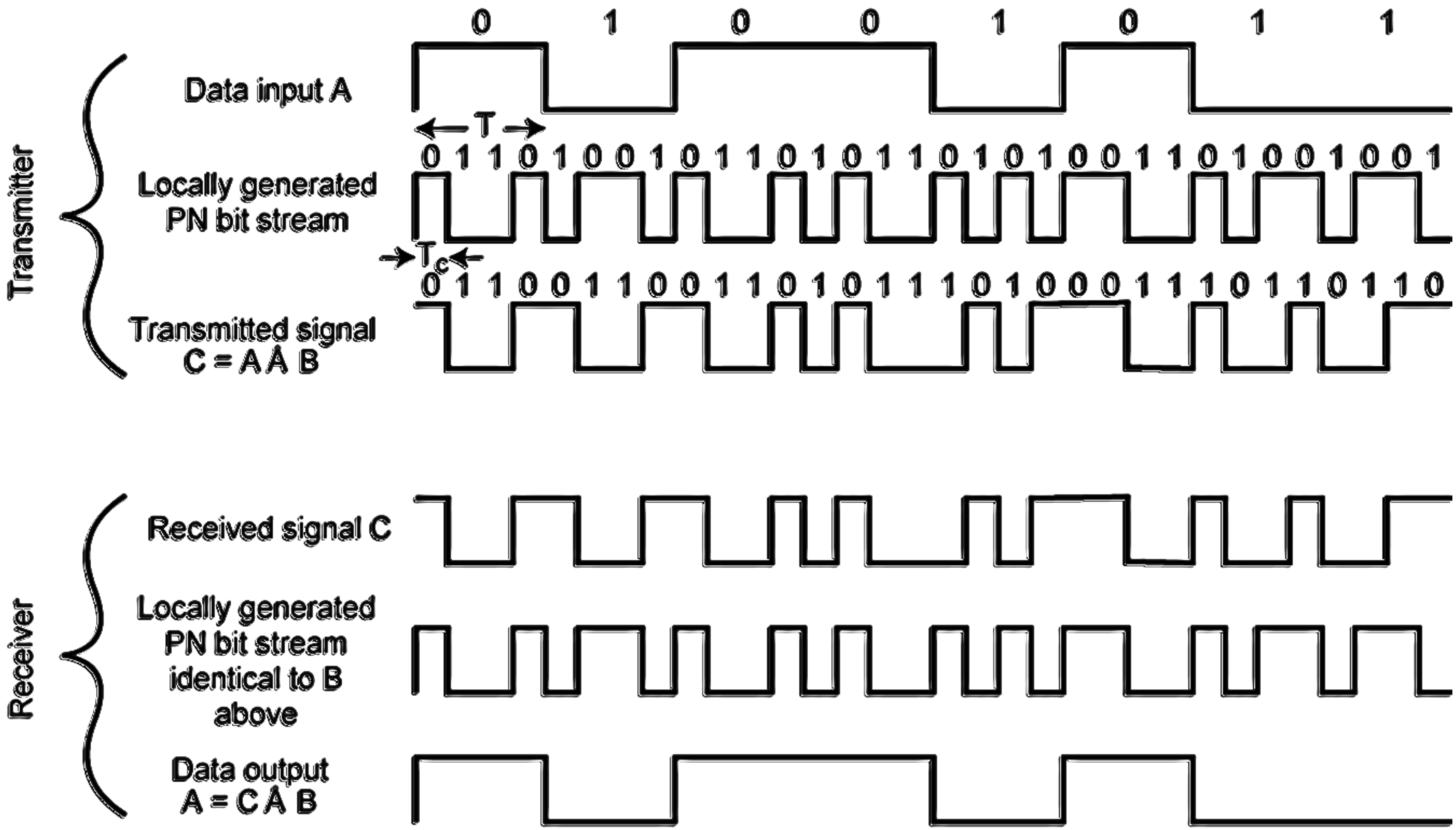


Correlation with local reference collapse the SS signal to its original narrowband

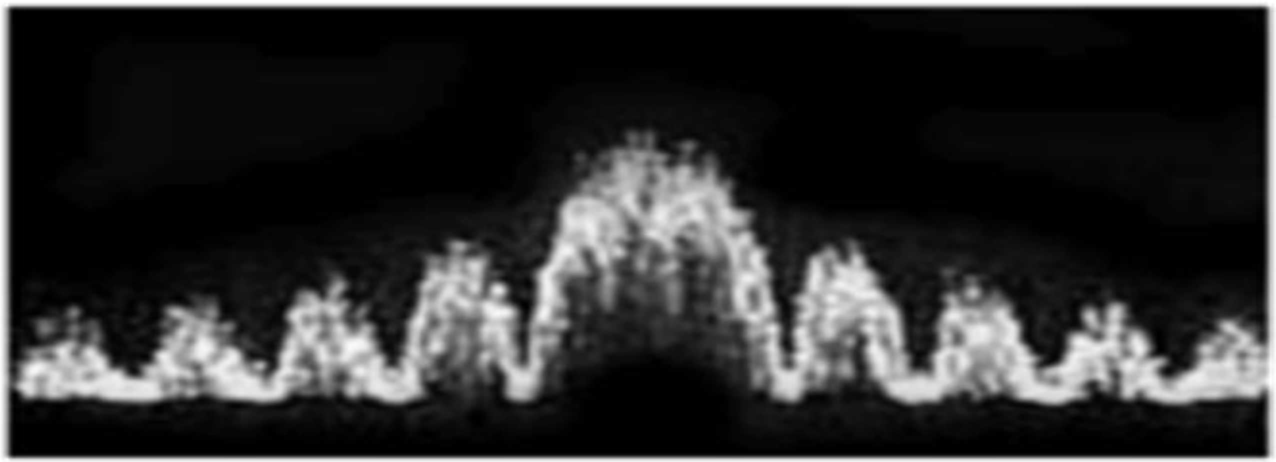
Alternative way to inject PN code



Spreading and Despreading



RF bandwidth of DSSS

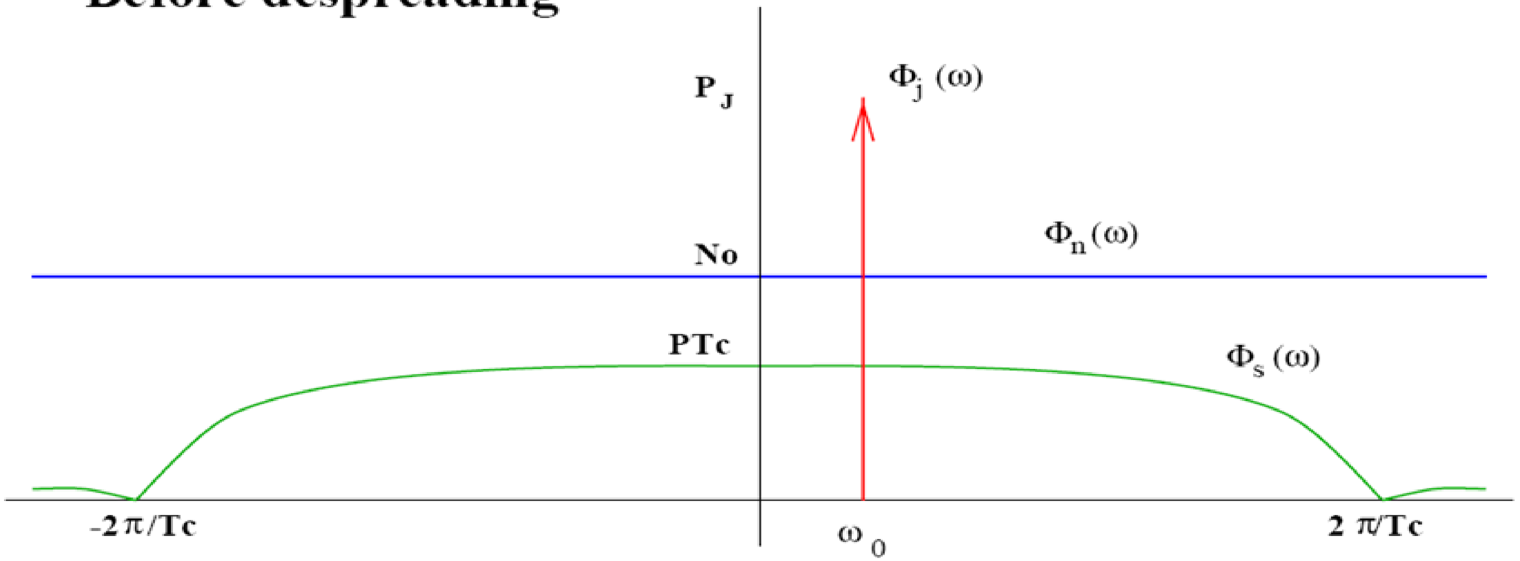


- Power distribution $\{(\sin x)/x\}^2$ …………..
- Null-to-null bandwidth is $2R_c$
- 90% of the power in the main-lobe
- Other modulations like QPSK , MFSK ……………

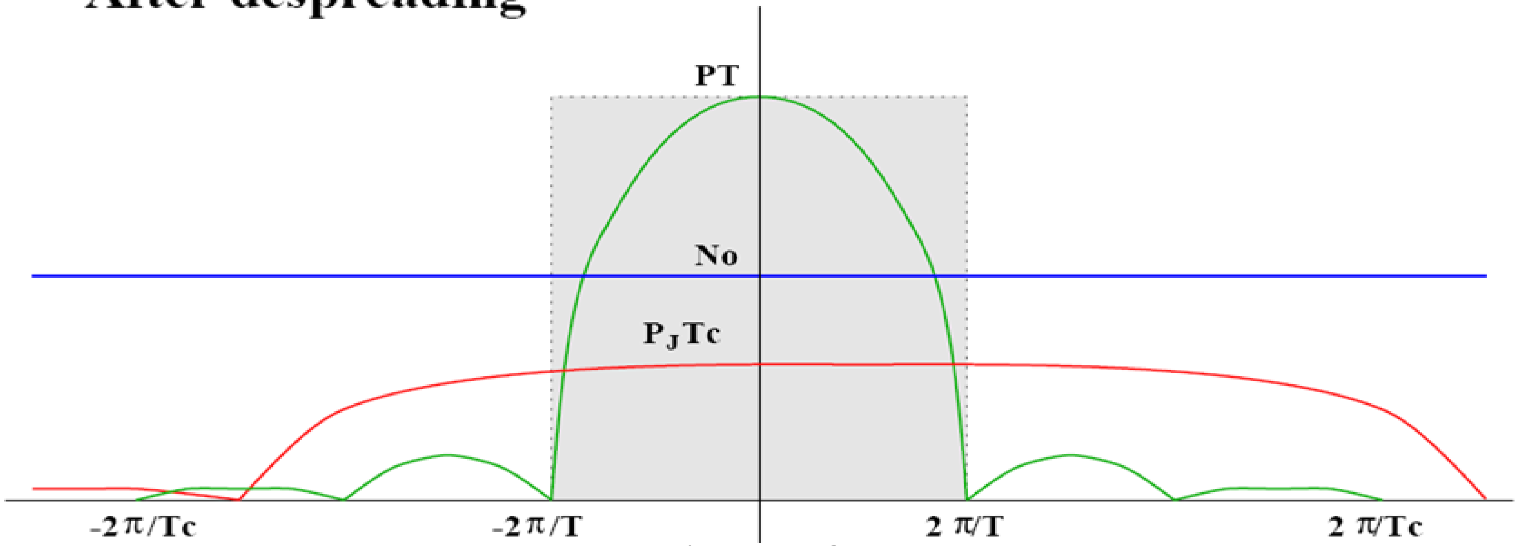
Spectrum of DSSS

- PN code is made up of a serious of variable-period pulses
- Durations vary from one code clock chip to chip for a max. length 2^n-1
- Each has (sinx)/x spectrum, the output spectrum is the composite
- For n-chip sequence generator, there is n+1 frequency sets, and the space of individual freq. components $R_c/(2^n-1)$

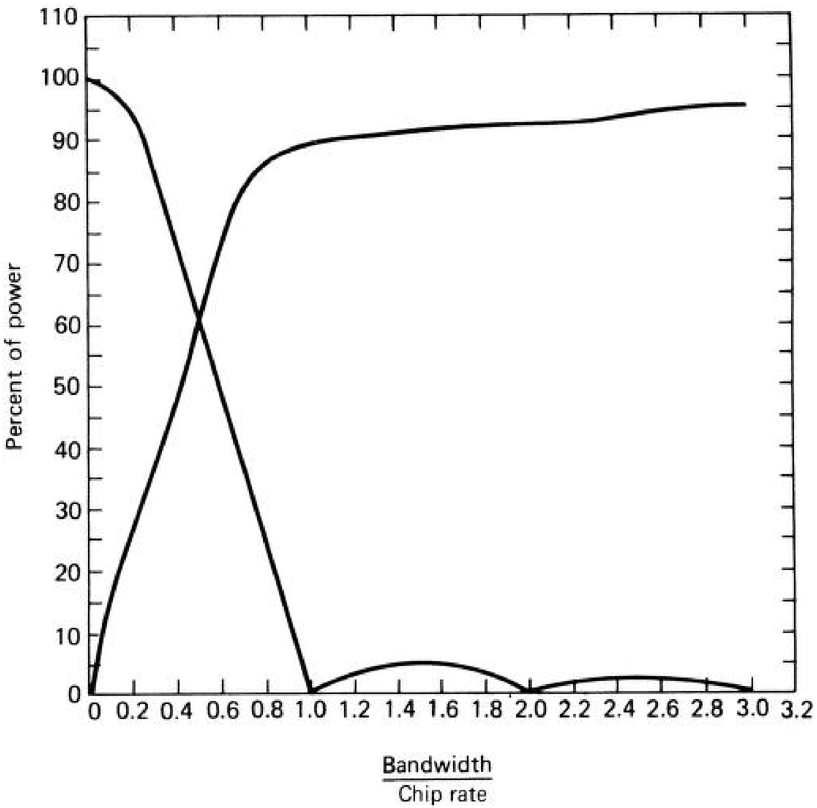
Before despreading



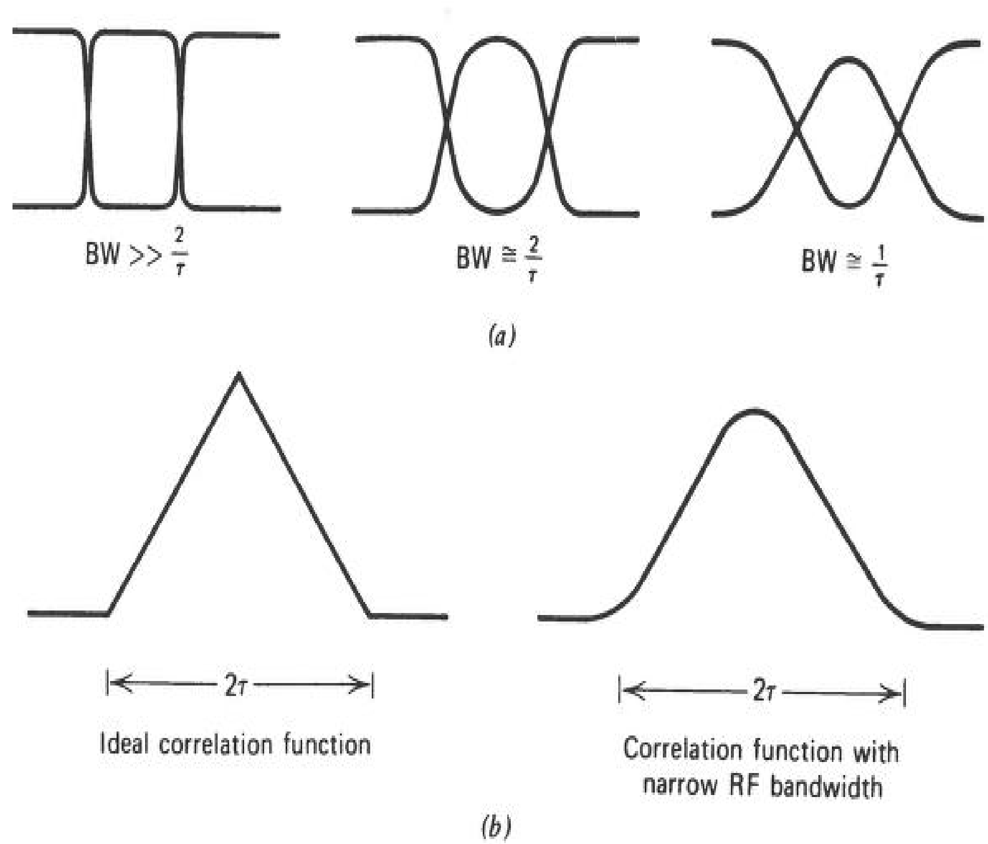
After despreading



RF Bandwidth Restriction



Power distribution in $[(\sin x)/x]^2$ spectrum.



The effect on signal envelope and correlation function.

- DS signals might have high energy in sidelobes
- That energy can be controlled using a proper waveform

Table 2.1 Comparison of Direct Sequence Waveforms

Waveform	Null-to-null Main Lobe BW	3-dB BW	First Sidelobe	Rolloff Rate
BPSK	2 × code clock	0.88 × code clock	−13 dB	6 dB/octave
PAM	2 × code clock	0.88 × code clock	−13 dB	6 dB/octave
QPSK	2 × code clock[a]	0.88 × code clock	−13 dB	6 dB/octave
QQPSK	2 × code clock[a]	0.88 × code clock	−13 dB	6 dB/octave
MSK (classic)	1.5 × code clock	0.66 × code clock	−23 dB	12 dB/octave

[a] Requires two codes at same rate as single BPSK code.

For higher Process gain

- For higher Gp, we need higher code rate. However there are some limitations as
  - Noise sensitive and more susceptible to error
  - Power consumption
  - Equipment Implementation