# Mobile Communication

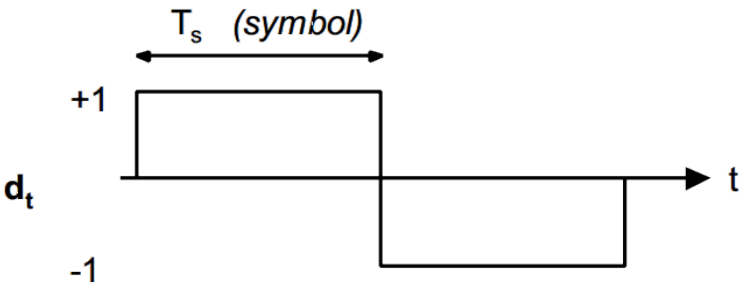
## DSSS and FHSS intermediate presentation

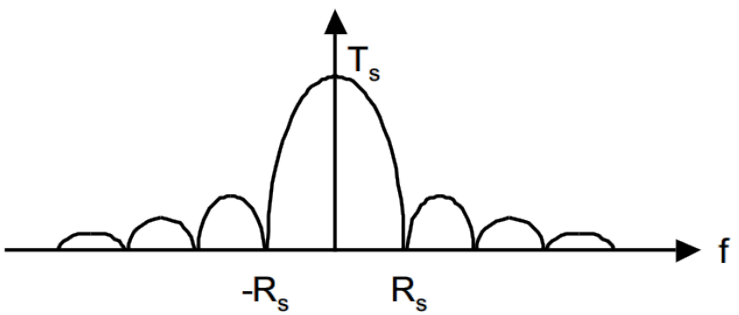
Group 6

October 29, 2014

# Spread Spectrum

- Transmitting finite sequences requires a frequency *band*
- Spreading this band makes transmission more robust
- Use spreading schemes, that allows using the frequency band for concurrent transmission



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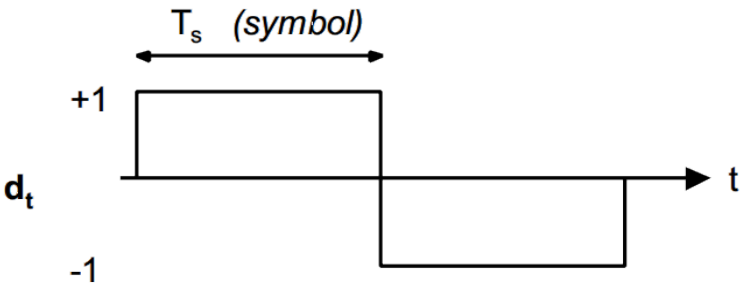


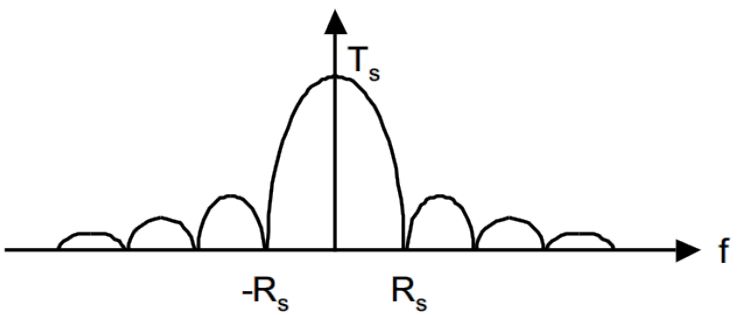

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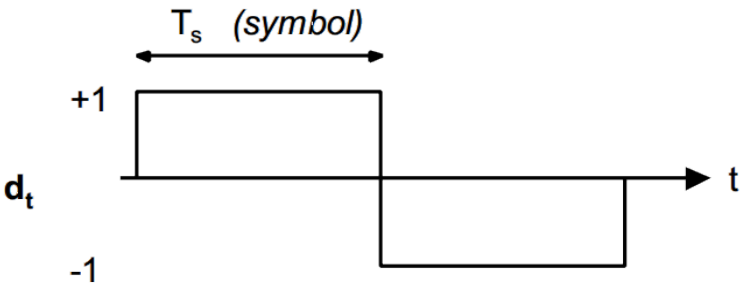
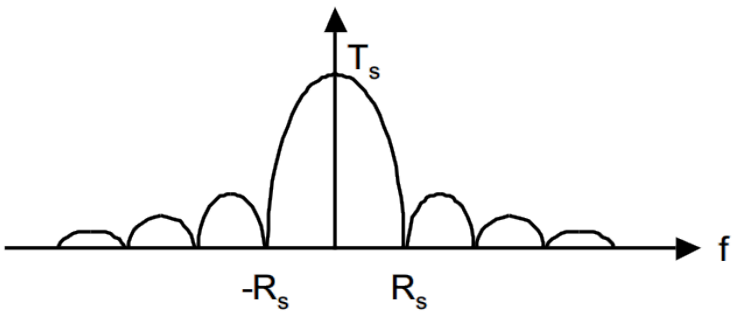
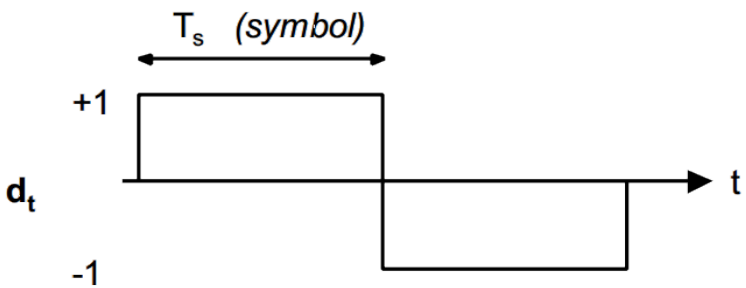


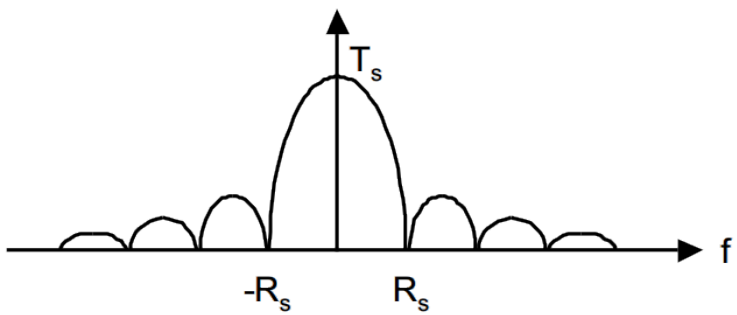



# Direct Sequence Spread Spectrum

## Data

- Let the data $d_t \in \{-1, 1\}^n$ be $d_t = [1, -1]$
- Signal bandwidth $R_s$



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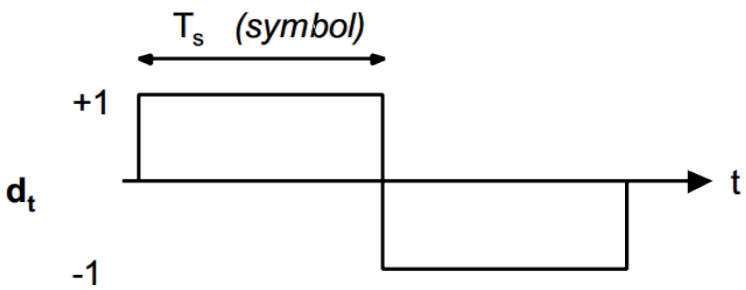


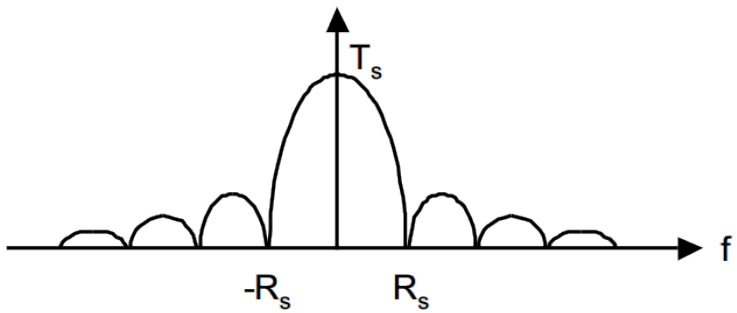

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## Chip Sequence

- Define chip sequence. Let the sequence $p_n \in \{-1, 1\}^n$ be $d_t = [1, 1, 1, -1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1]$
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- $p_n$ is known to sender and receiver only
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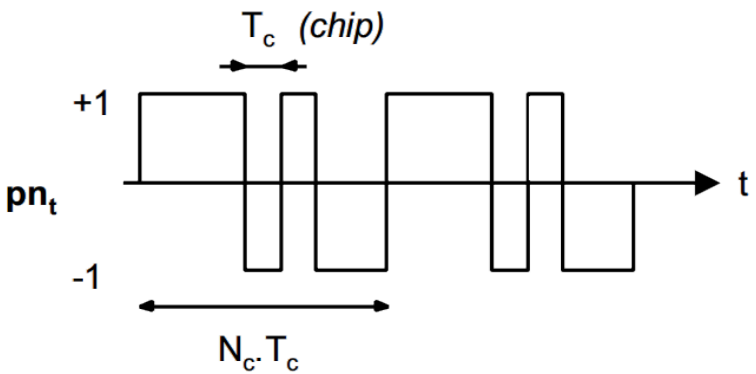


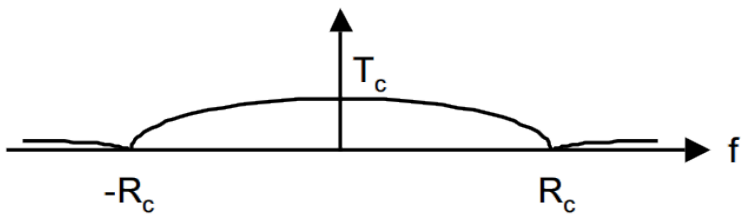

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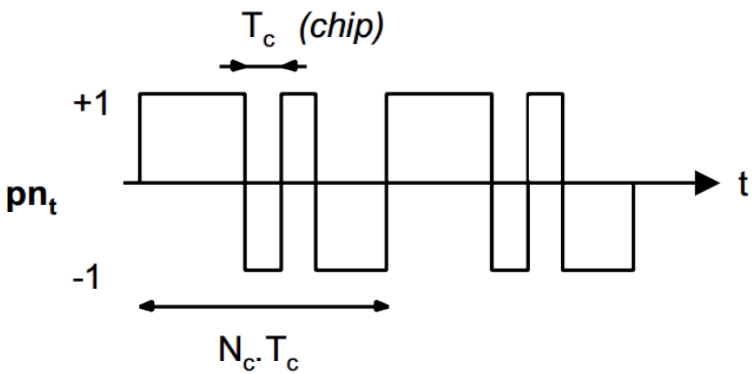


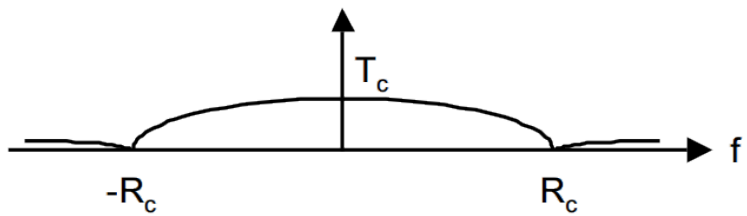

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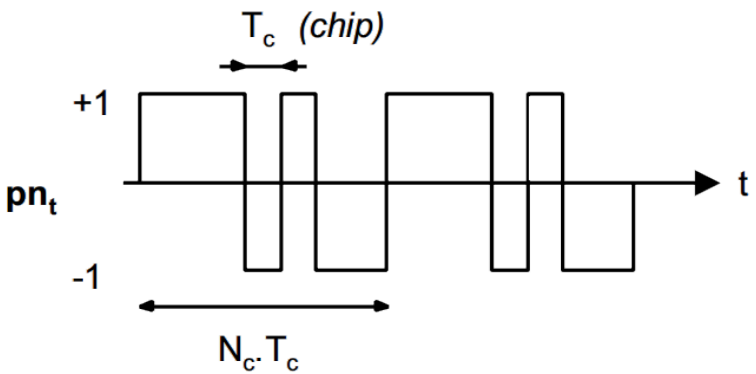


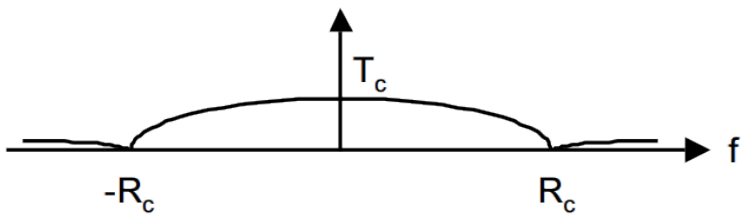

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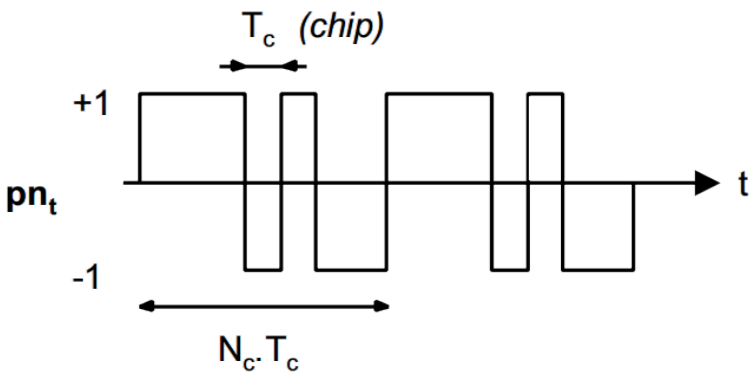


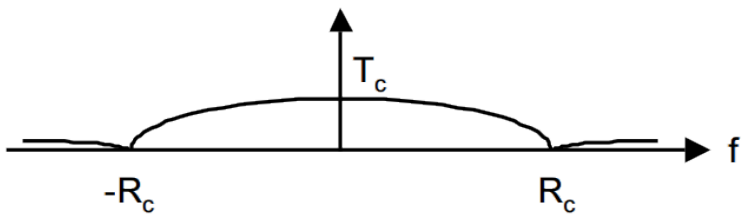

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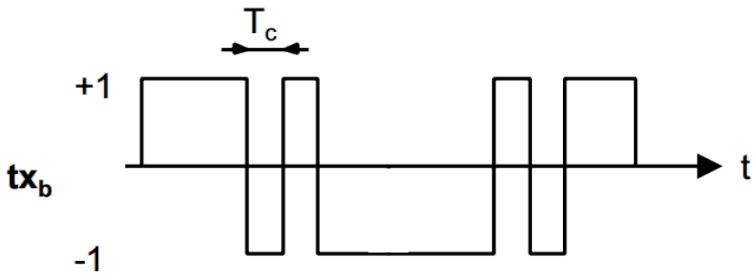


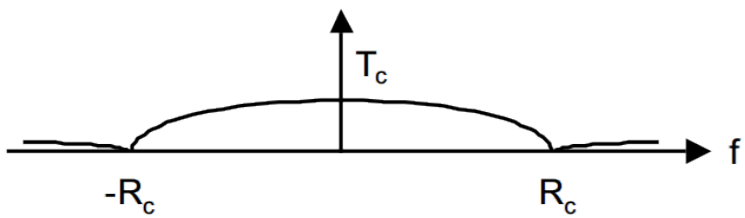

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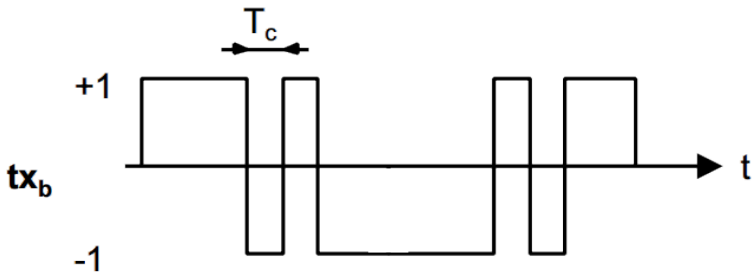


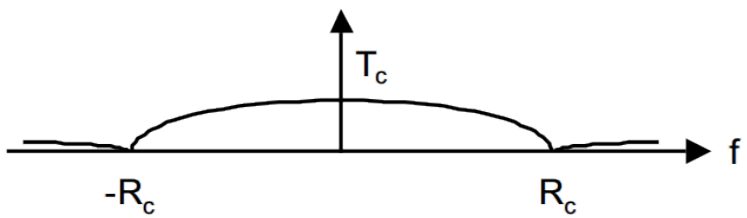

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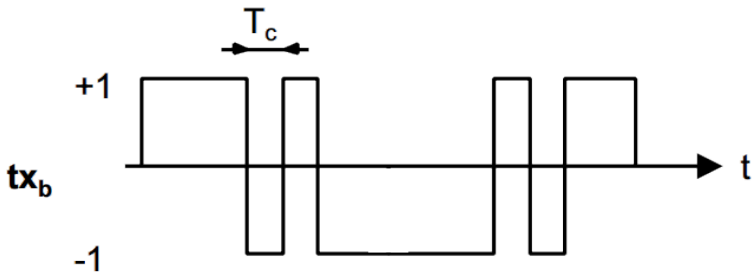


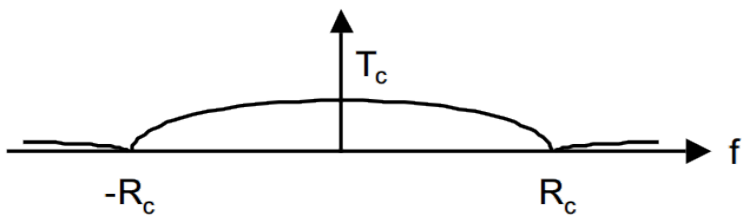

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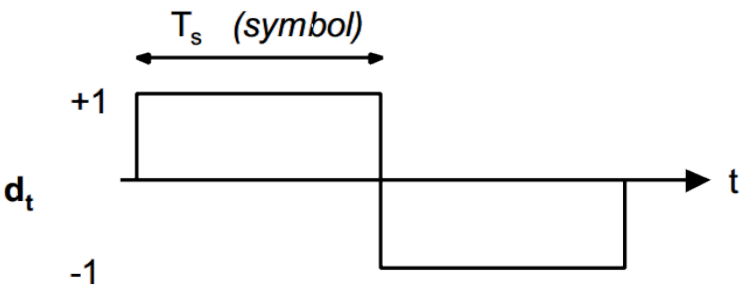


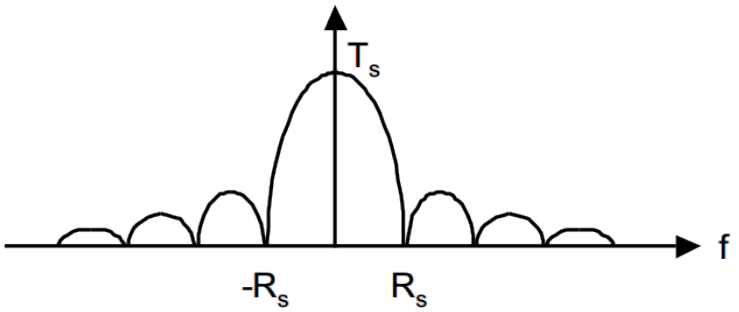

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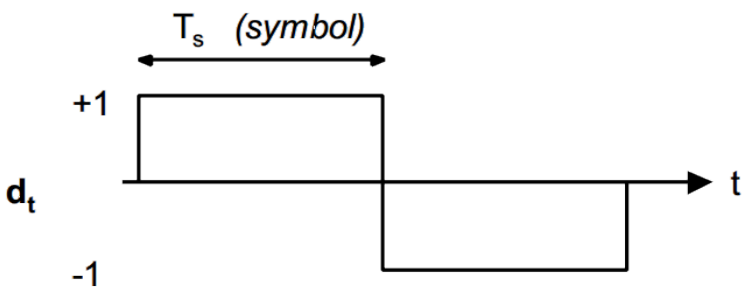
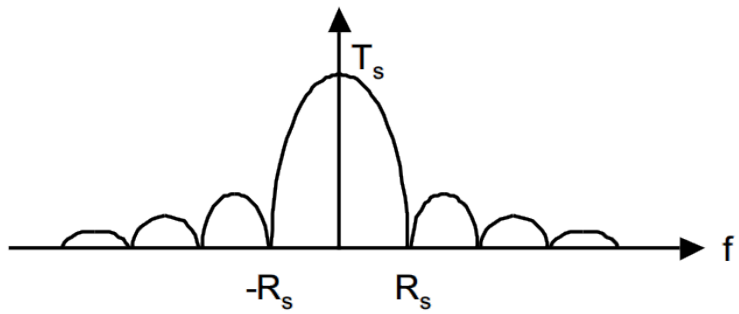
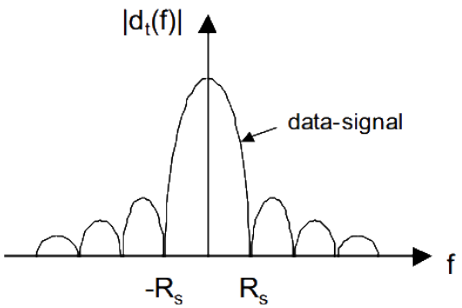


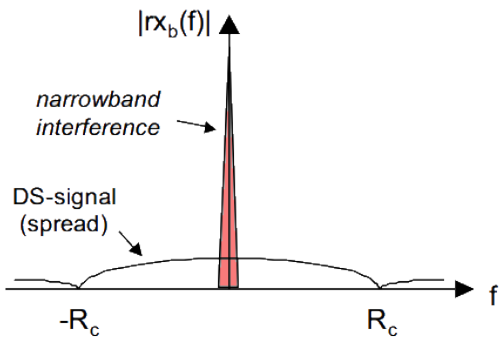



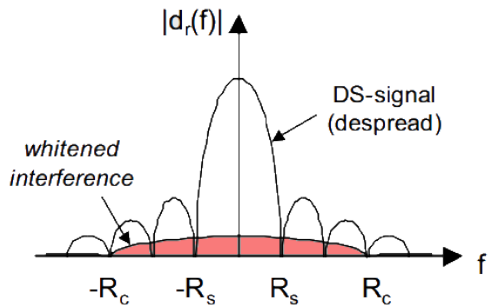
# Interference

## Narrow-band Interference

- Narrowband interference is spread in the despreading part
- Remember: spreading and despreading is the same operation
- Does not lower the SNR too much



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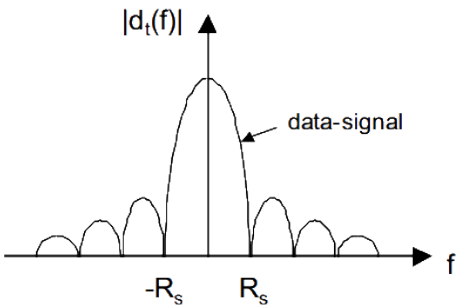


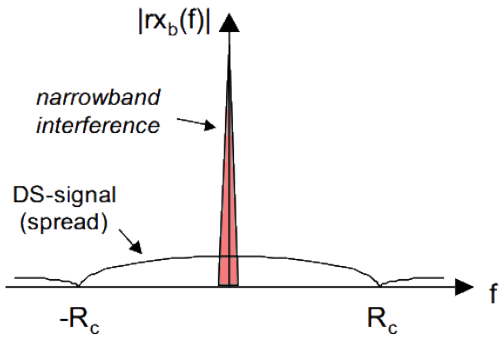


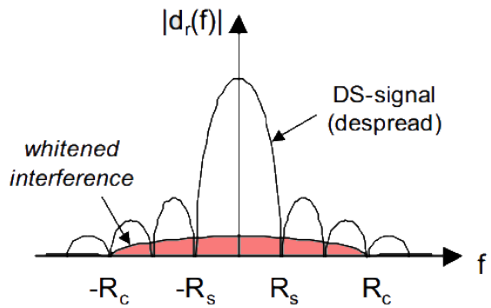

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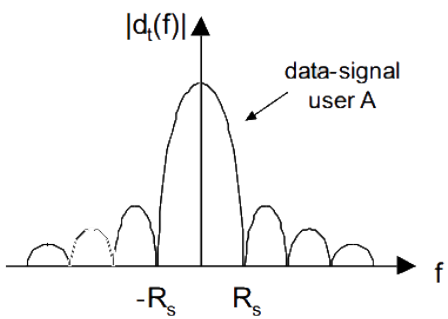
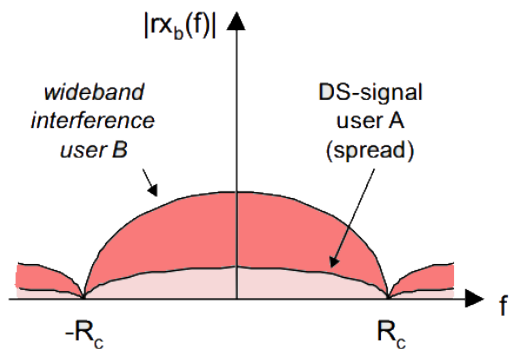
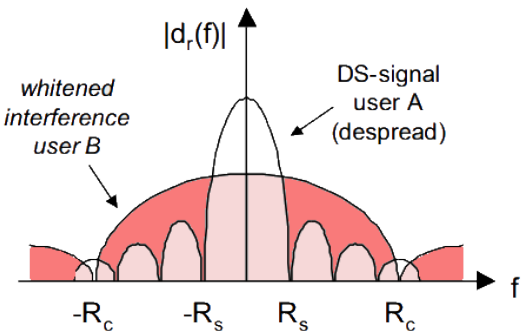
## Broad-band Interference

- Despreading does not change the broad-band noise, it is uncorrelated with $p_n$. It's bandwidth remains the same.
- Can affect the SNR.
- Transmissions of other users are received as broadband noise



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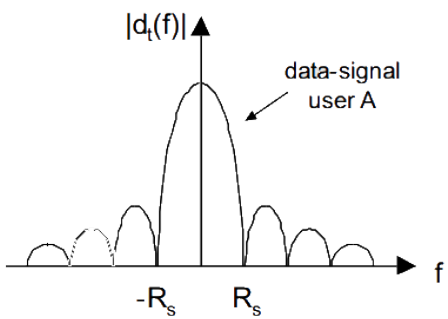


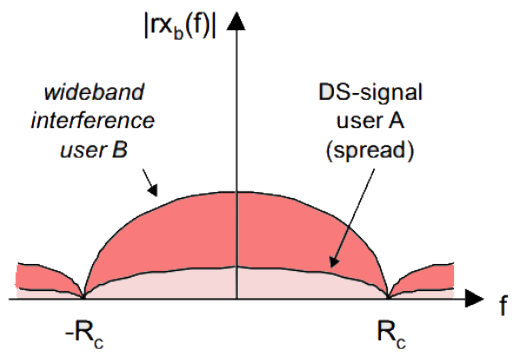


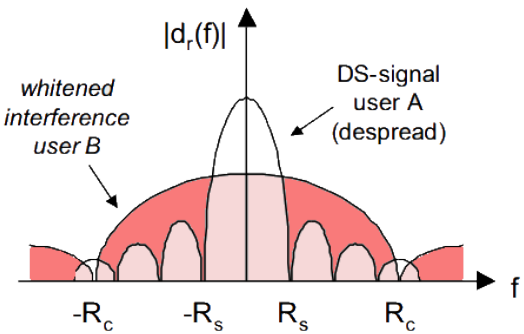

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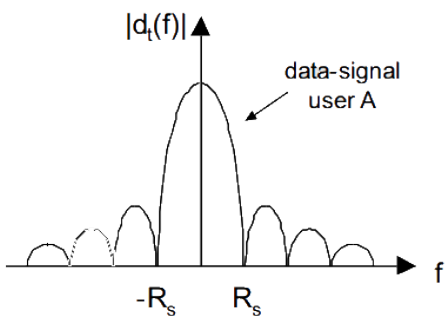


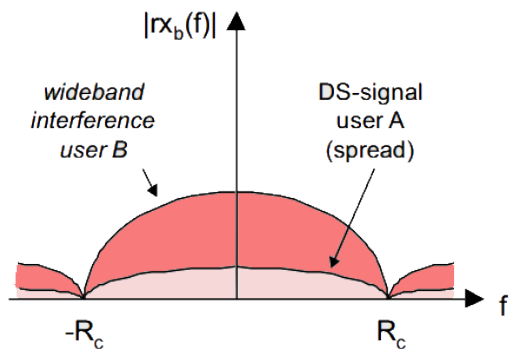


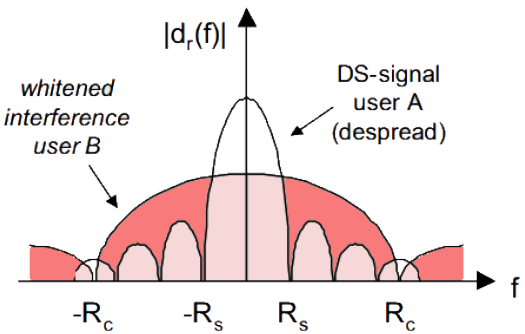

# Frequency Hopping Spread Spectrum

- Divide frequency band into *N* sub-bands
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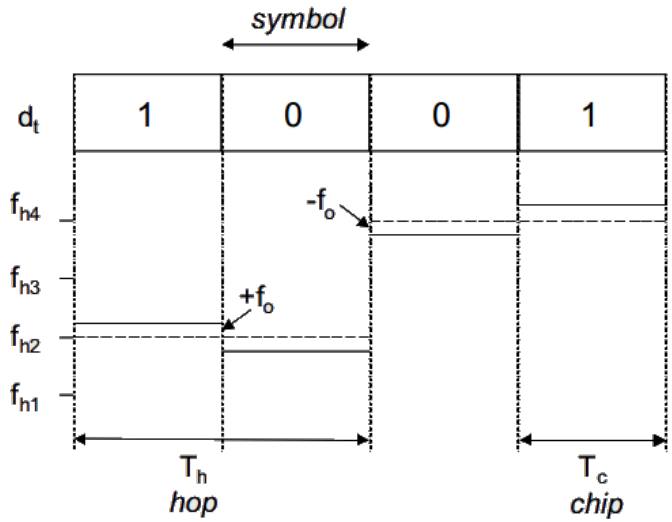


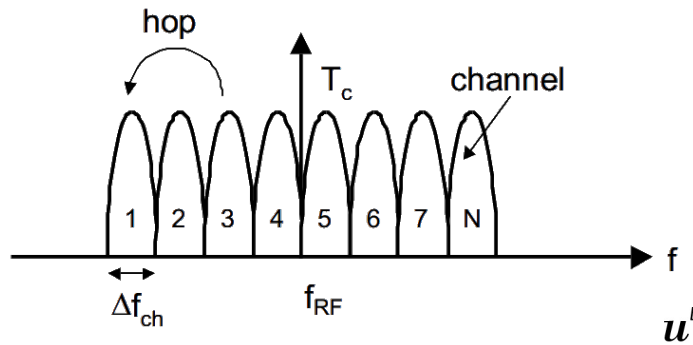

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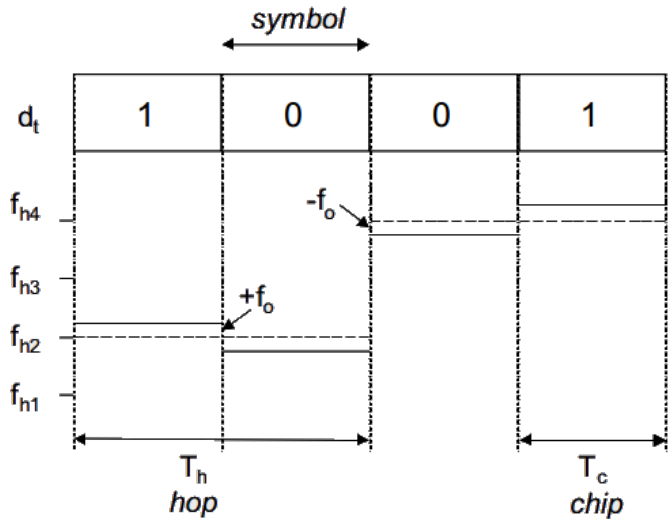


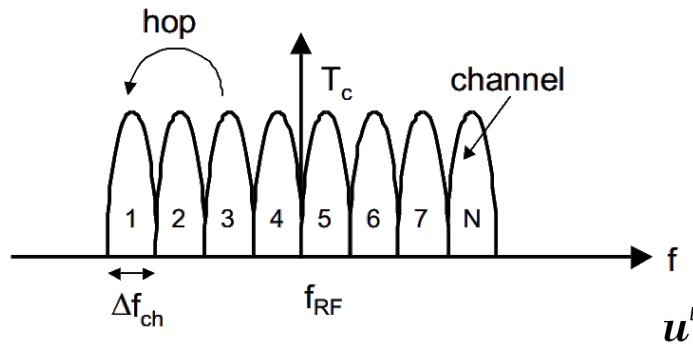

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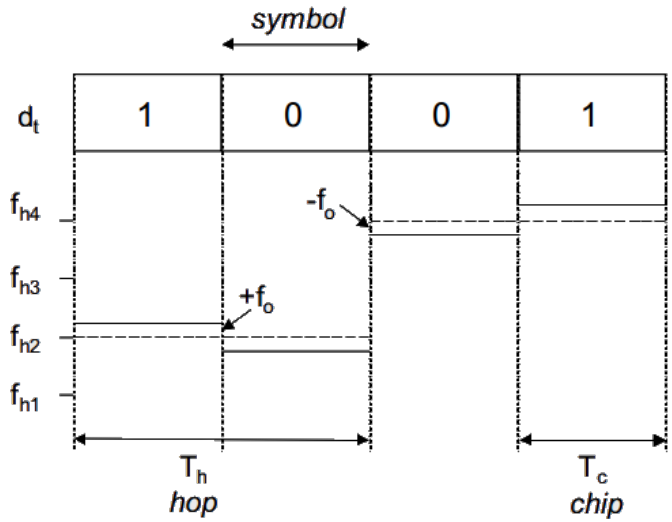


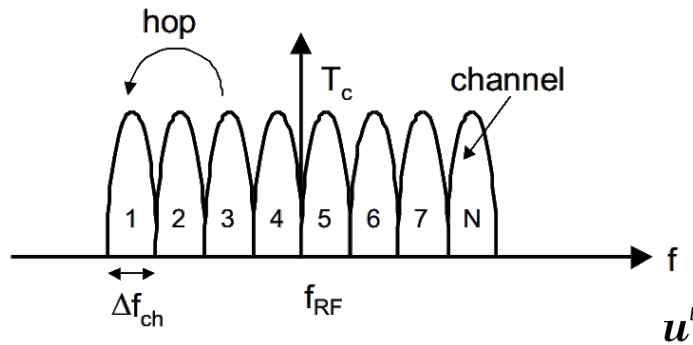

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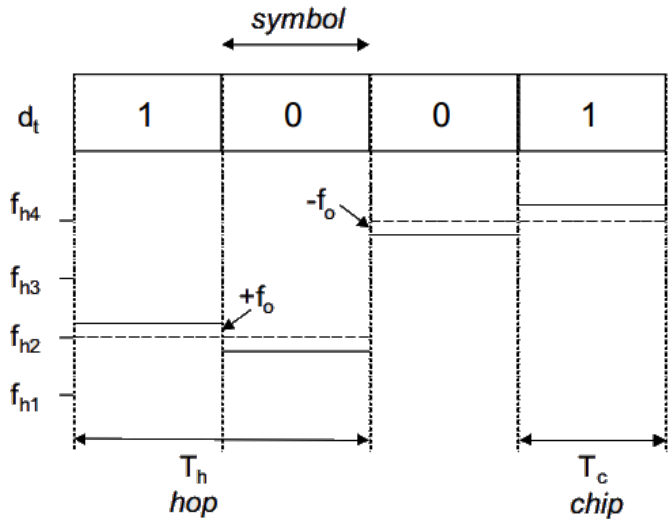


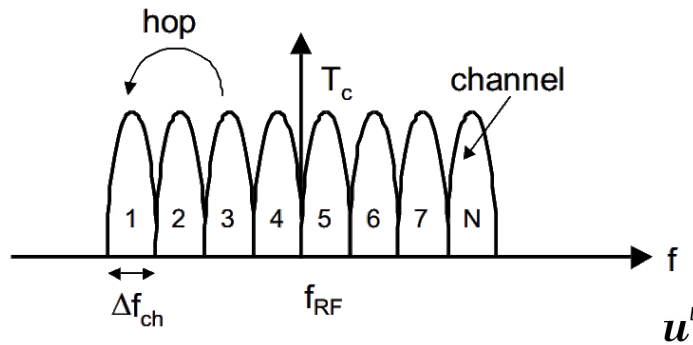

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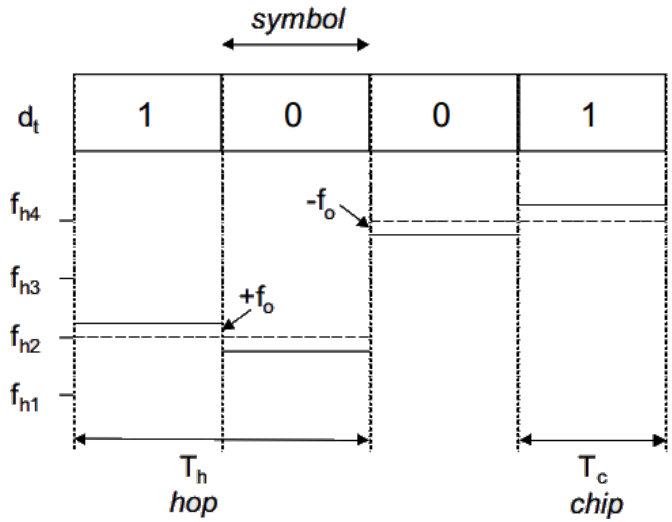
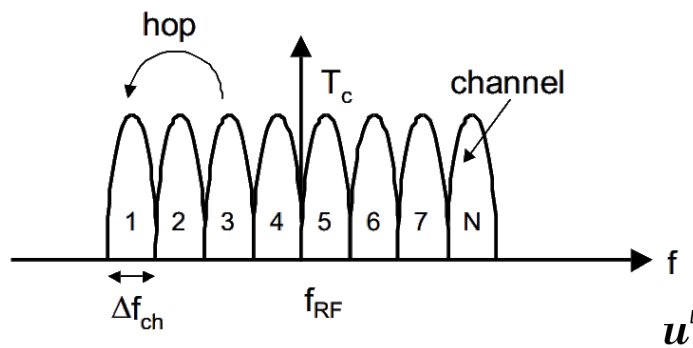
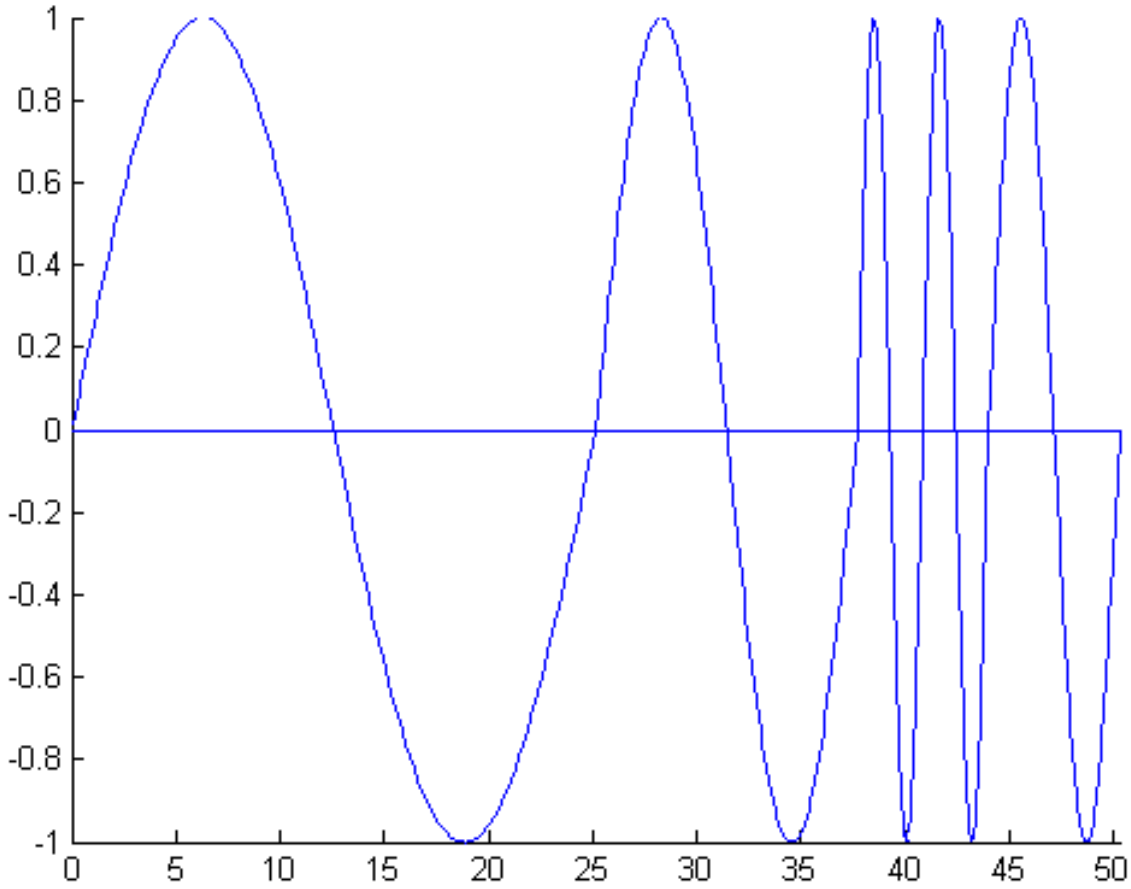


# FHSS

## Example



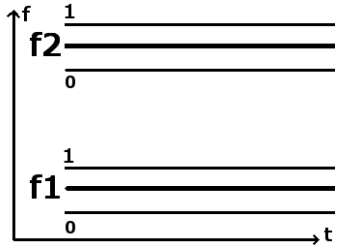
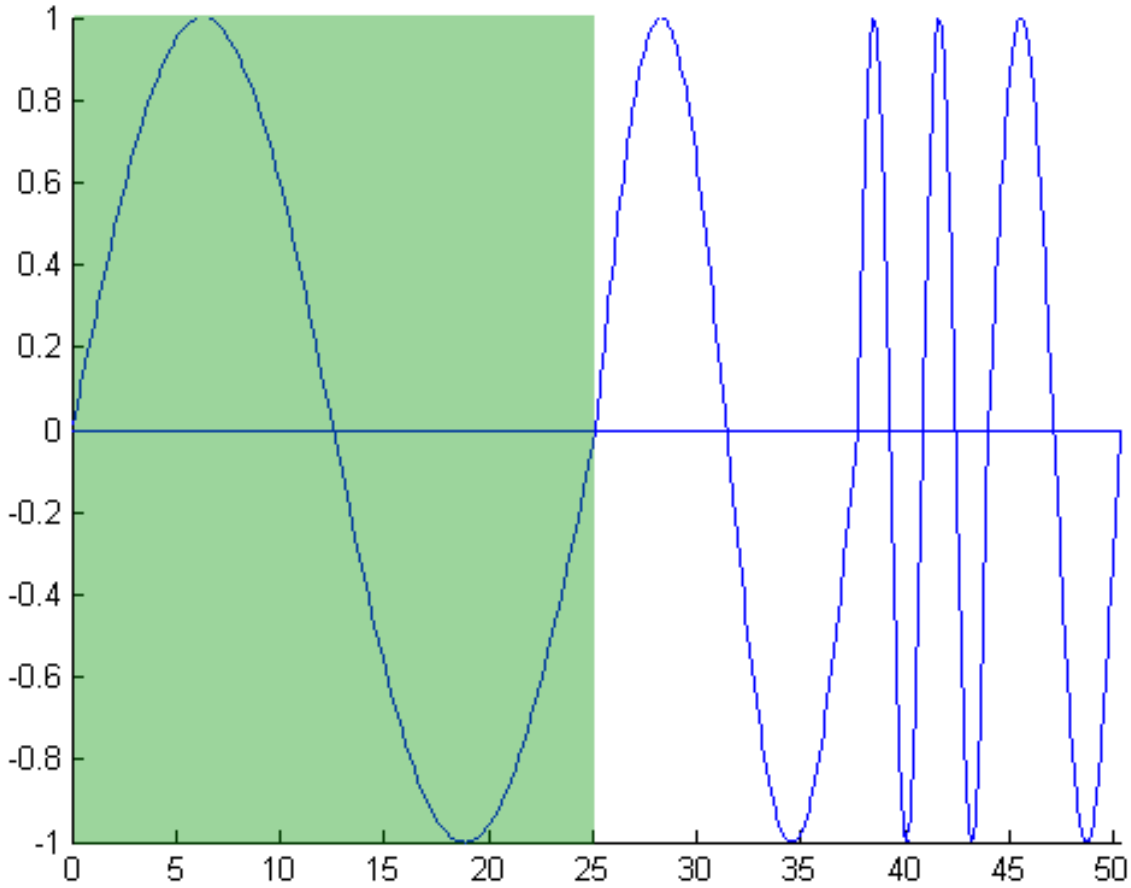




Figure: Frequency = , value =

# FHSS

## Example



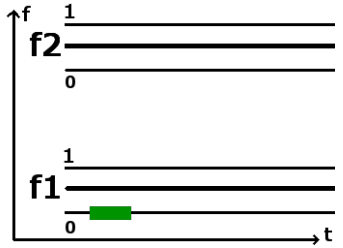
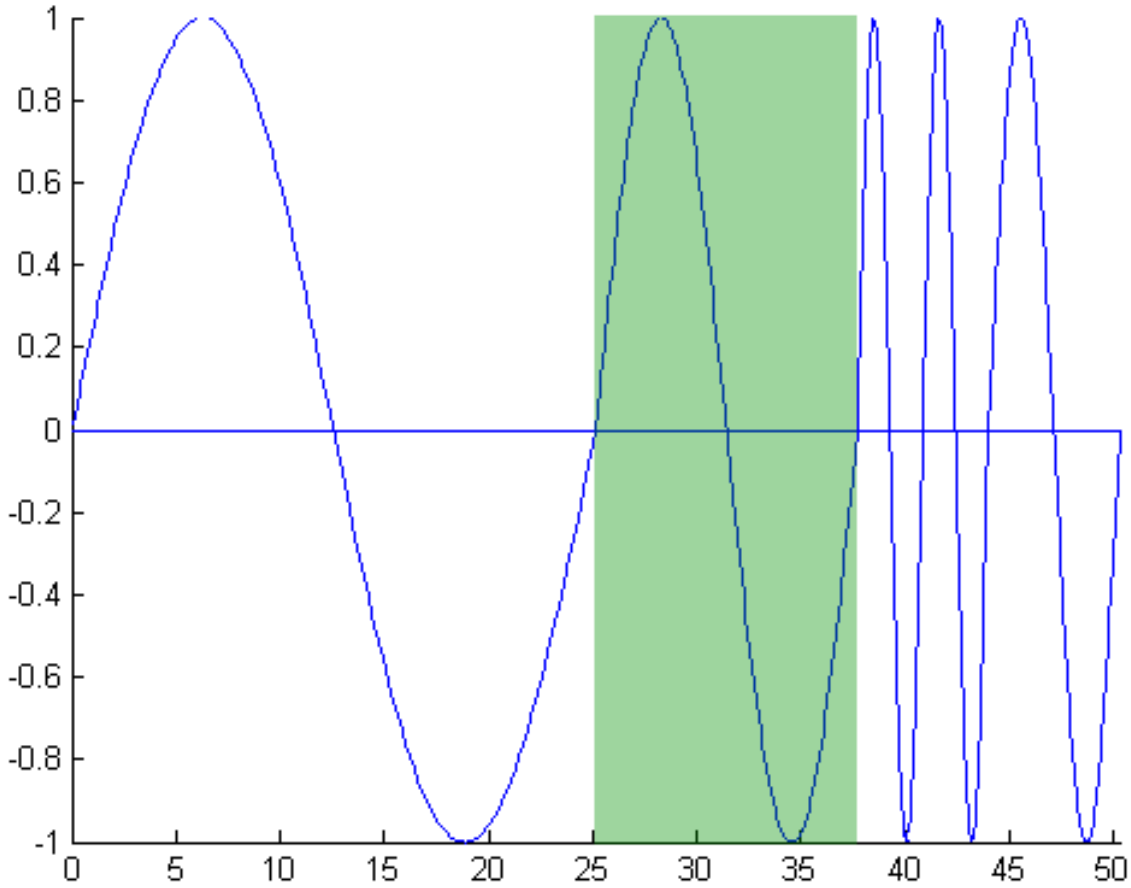




Figure: Frequency = f1, value = 0

# FHSS

## Example



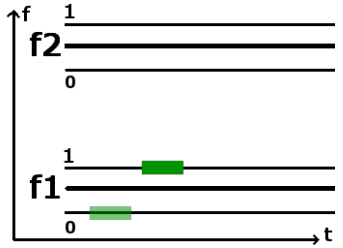
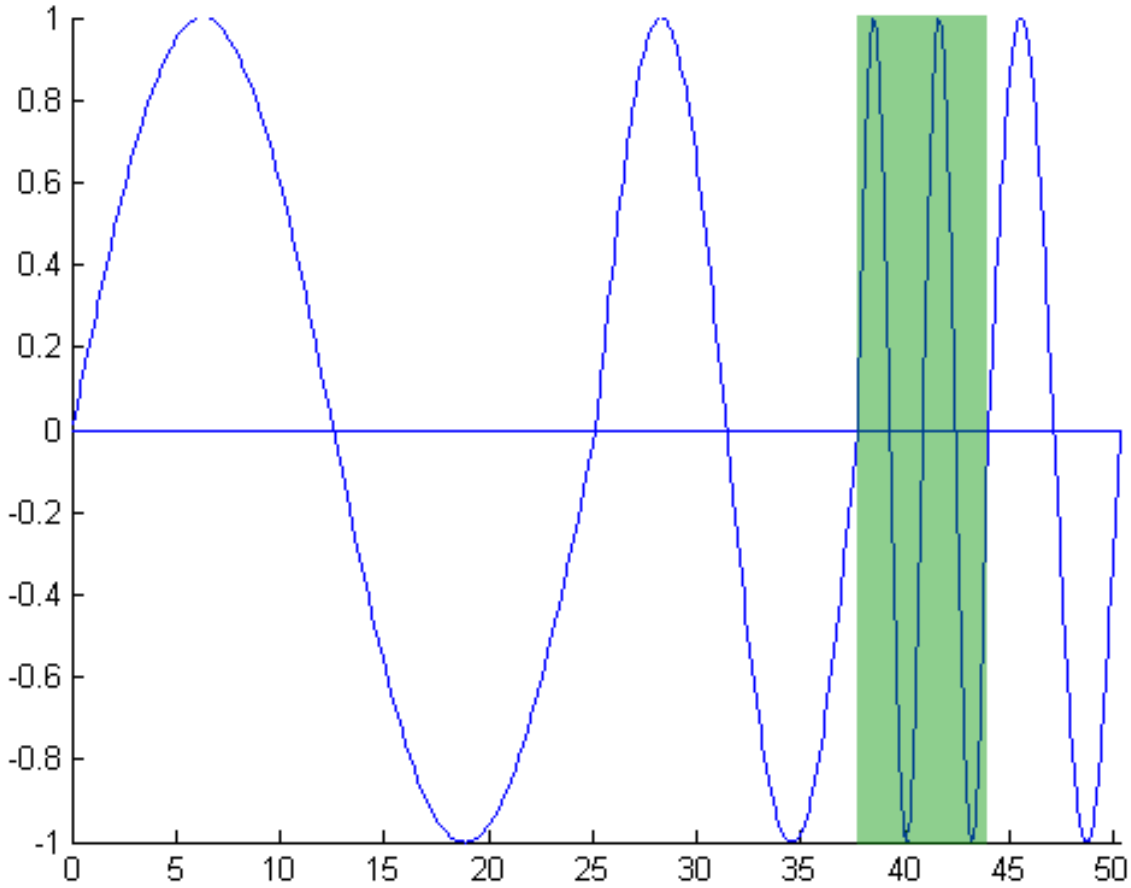




Figure: Frequency = f1, value = 1

# FHSS

## Example



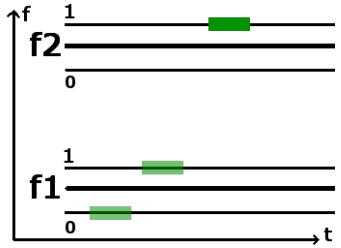
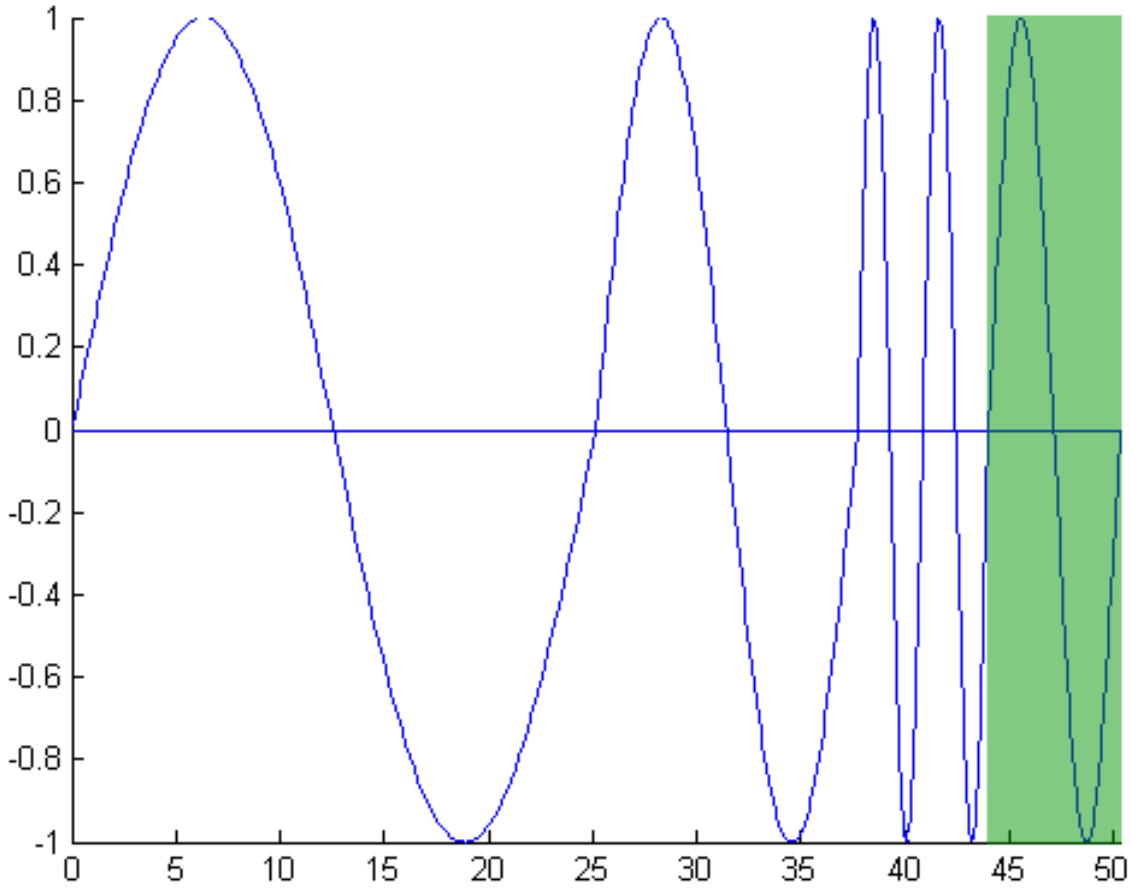




Figure: Frequency = f2, value = 1

# FHSS

## Example



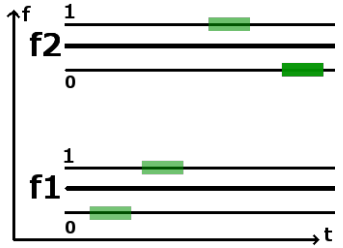




Figure: Frequency = f2, value = 0

# Interference

- Robust with *narrow-band* interference, since transmission remains only for a few symbols on on frequency
- Problems with *broad-band* interference remain
- Other users will be perceived as narrow-band interference

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# DSSS

- First
- Second
- third

# DSSS

- First
- Second
- third

# DSSS

- First
- Second
- third

# Some other frame

some test

Some more text

Some other text

# Some other frame

some test

Some more text

Some other text