

# BandPass (4A)

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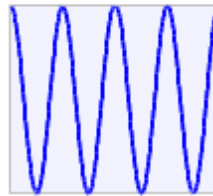
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# Binary ASK (Amplitude Shift Keying)

$$s_0(t) = \sqrt{\frac{2E_0(t)}{T}} \cos(\omega_0 t + \Phi)$$



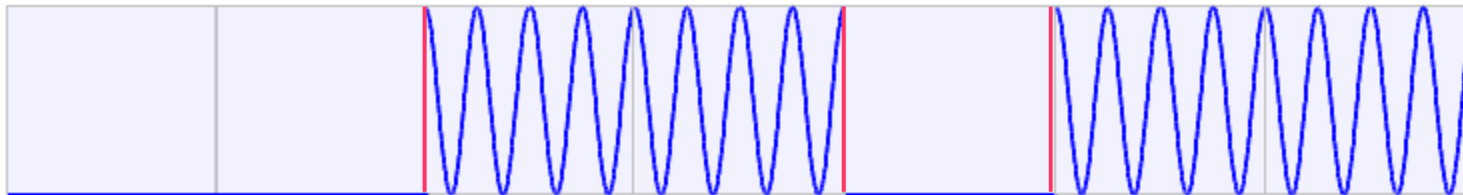
$$s_1(t) = \sqrt{\frac{2E_1(t)}{T}} \cos(\omega_0 t + \Phi)$$



$T$

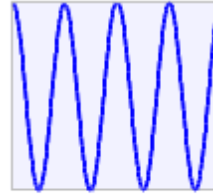
A horizontal double-headed arrow below the boxes, labeled with the variable T, indicating the duration of one bit period.

0      0      1      1      0      1      1

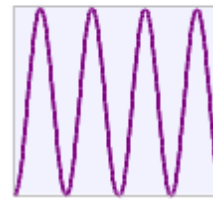


# Binary PSK (Phase Shift Keying)

$$s_0(t) = \sqrt{\frac{2E}{T}} \cos(\omega_0 t + \frac{2\pi \cdot 0}{2})$$



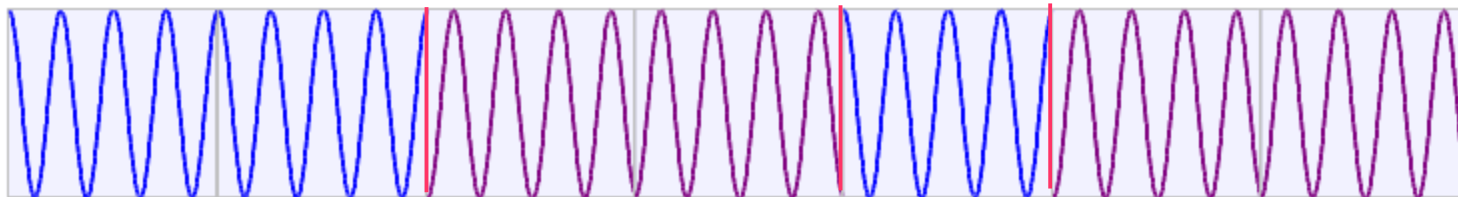
$$s_1(t) = \sqrt{\frac{2E}{T}} \cos(\omega_0 t + \frac{2\pi \cdot 1}{2})$$



$T$

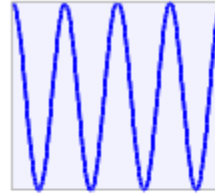
A horizontal double-headed arrow indicating the duration of one symbol, labeled with the variable T.

0      0      1      1      0      1      1

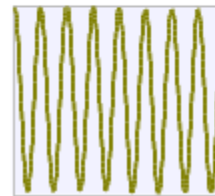


# Binary FSK (Frequency Shift Keying)

$$s_0(t) = \sqrt{\frac{2E}{T}} \cos(\omega_0 t + \Phi)$$



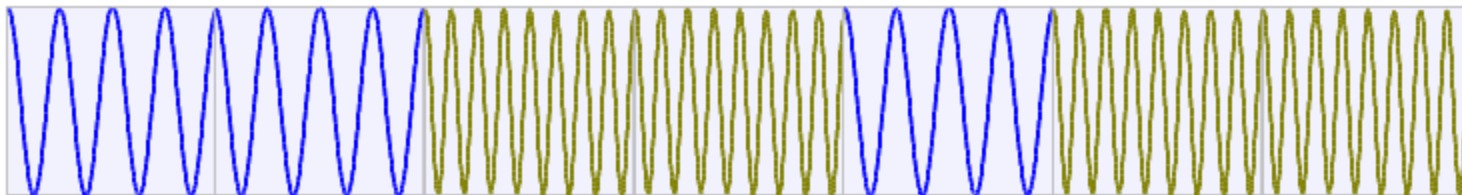
$$s_1(t) = \sqrt{\frac{2E}{T}} \cos(\omega_1 t + \Phi)$$



$T$

A horizontal double-headed arrow indicating the duration of one symbol, labeled with the variable T.

0      0      1      1      0      1      1



# Coherent and Non-Coherent Detection

## Coherent Detection

The Sinusoidal Reference Signal  
is **synchronous** in phase  
with the carrier wave used in the modulator

Phase Locked Loop

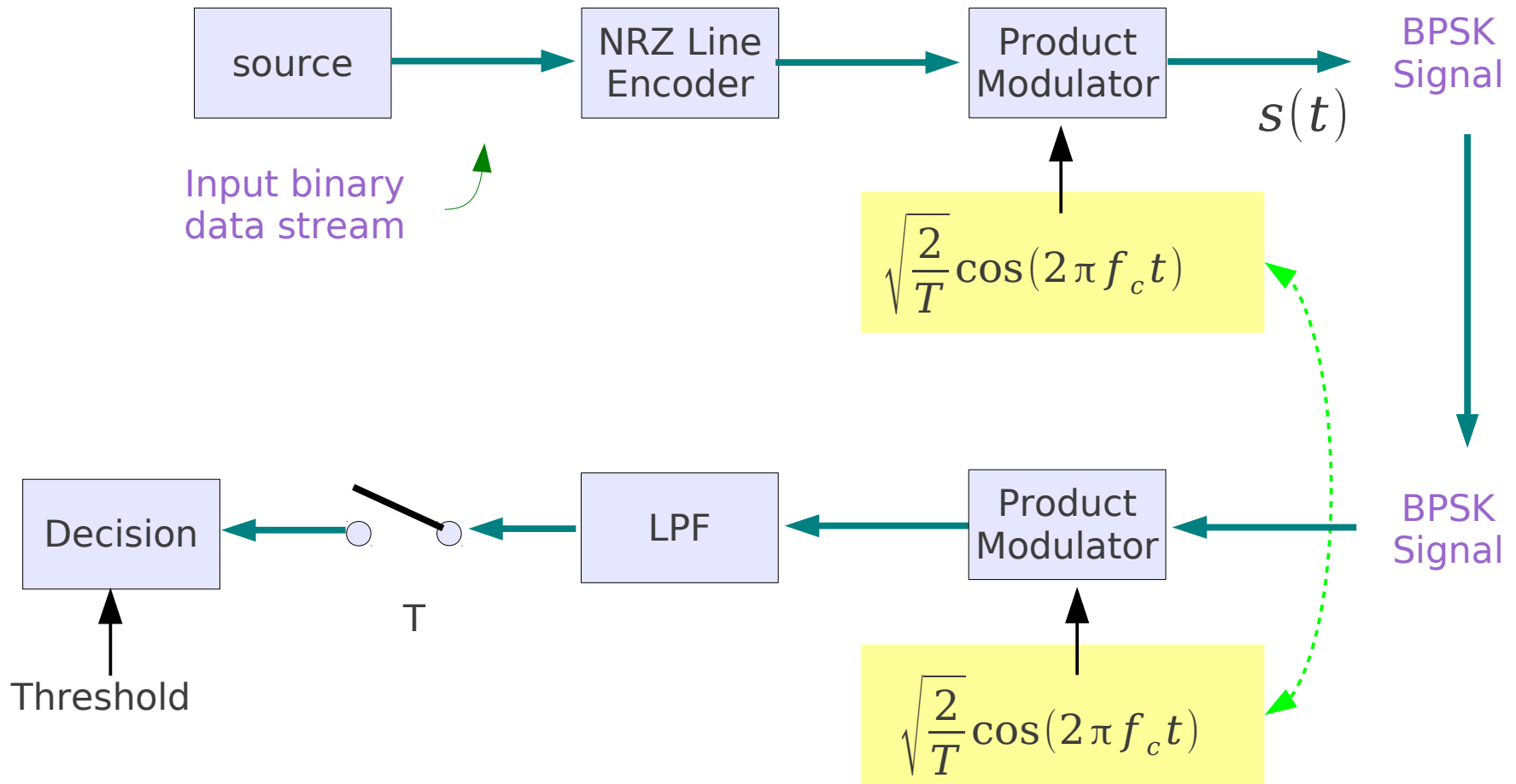
Synchronous Phase  
Symbol Interval

Cost

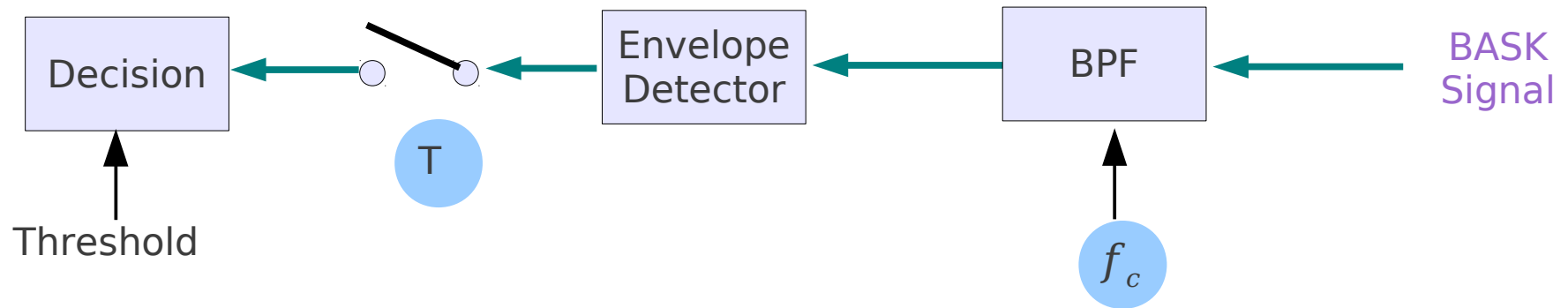
## Non-Coherent Detection

Abandon phase synchronization

# Coherent Detection of BPSK signals

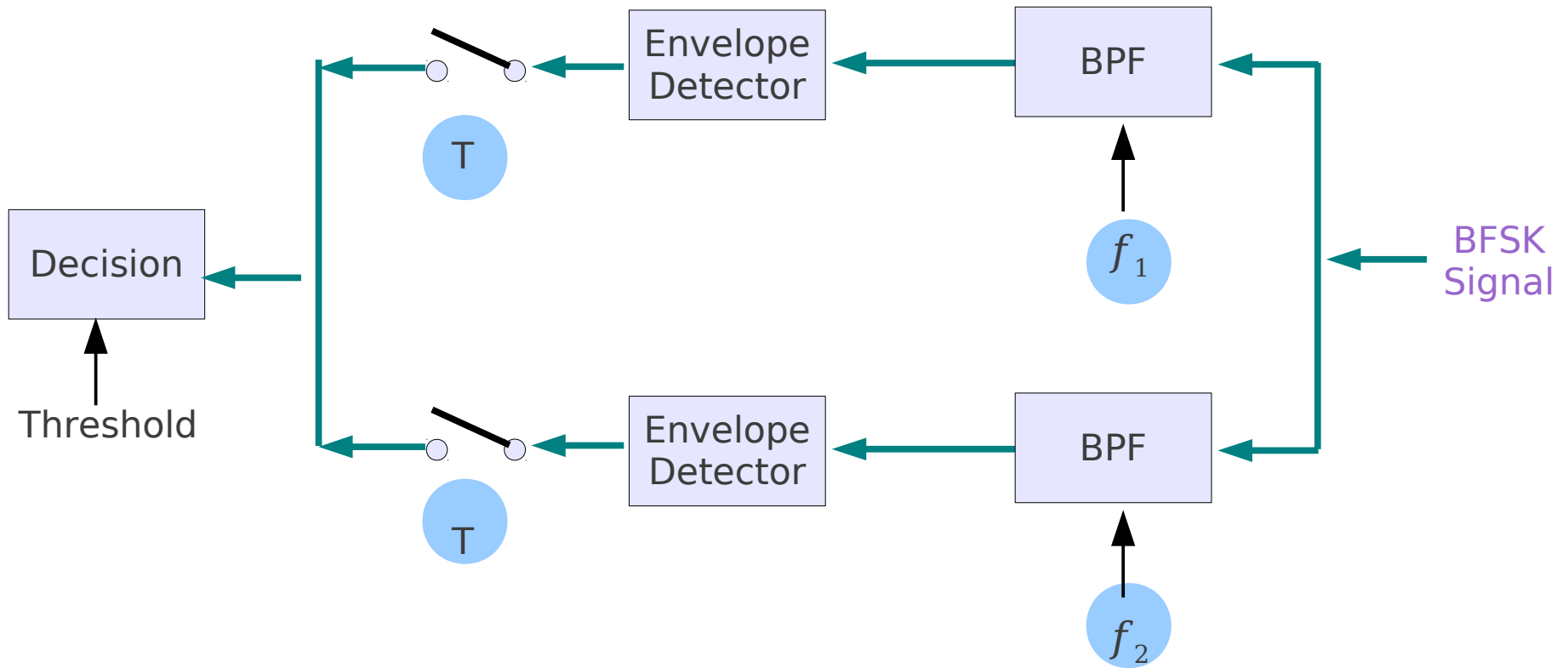


# Non-Coherent Detection of BASK signals



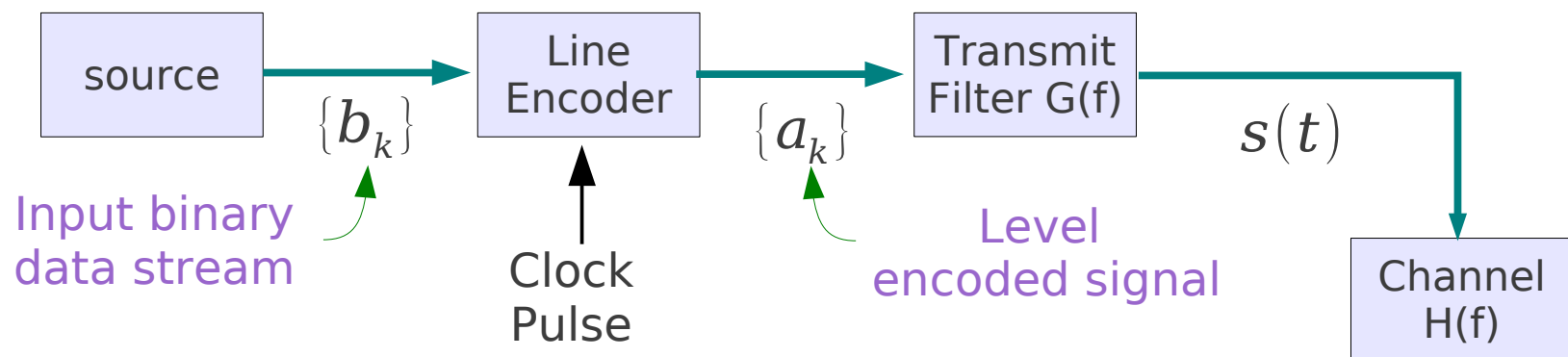


# Non-Coherent Detection of BFSK signals



# M-ary PAM

The amplitude of transmitted pulses is varied in a discrete manner in accordance with an input stream of digital data



M-ary PAM Bit Rate

$$T = T_b \log_2 M$$

M possible amplitude level ( $M > 2$ )  
M symbols  
Transmits sequence of symbols

T: Symbol duration  
 $1/T$  : Symbol rate

Binary PAM  
 $T_b$  : Bit duration  
 $1/T_b$  : Bit rate

# Line Encode

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NRZ  
RZ  
...

# Signal Space

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# Autocorrelation of Random and Power Signals

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# Time Averaging and Ergodicity

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# Autocorrelation of Random and Power Signals

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# Time Averaging and Ergodicity

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## References

- [1] <http://en.wikipedia.org/>
- [2] <http://planetmath.org/>
- [3] B. Sklar, "Digital Communications: Fundamentals and Applications"