

# Important Data Transmissions and Error Analysis Formulas PDF



**Formulas  
Examples  
with Units**

## List of 14 Important Data Transmissions and Error Analysis Formulas

### 1) Average Probability of Correct Decision Formula ↻

Formula

$$P_c = 1 - P_e$$

Example

$$0.6 = 1 - 0.4$$

Evaluate Formula ↻

### 2) Average Probability of Error Formula ↻

Formula

$$P_e = 1 - P_c$$

Example

$$0.4 = 1 - 0.6$$

Evaluate Formula ↻

### 3) Average Signal Power Formula ↻

Formula

$$P_{av} = P_{ab} \cdot B_{sym}$$

Example with Units

$$2.4w = 0.30 \cdot 8bits$$

Evaluate Formula ↻

### 4) Average Signal Power for Two Dimensional Constellation Formula ↻

Formula

$$P_{av} = 2 \cdot SNR_{av} \cdot P_{an}$$

Example with Units

$$2.448w = 2 \cdot 0.72 \cdot 1.7w$$

Evaluate Formula ↻

### 5) Average Signal Power per Bit Formula ↻

Formula

$$P_{ab} = \frac{P_{av}}{B_{sym}}$$

Example with Units

$$0.3062 = \frac{2.45w}{8bits}$$

Evaluate Formula ↻

### 6) Average SNR for Two Dimensional Constellation Formula ↻

Formula

$$SNR_{av} = \frac{P_{av}}{2 \cdot P_{an}}$$

Example with Units

$$0.7206 = \frac{2.45w}{2 \cdot 1.7w}$$

Evaluate Formula ↻



## 7) Average SNR per Bit Formula

Formula

$$\text{SNR}_{\text{ab}} = \frac{P_{\text{av}}}{2 \cdot B_{\text{sym}} \cdot P_{\text{an}}}$$

Example with Units

$$0.0901 = \frac{2.45 \text{ W}}{2 \cdot 8 \text{ bits} \cdot 1.7 \text{ W}}$$

Evaluate Formula 

## 8) Bit Error Rate Formula

Formula

$$\text{BER} = \frac{N_e}{N_t}$$

Example

$$0.6 = \frac{3}{5}$$

Evaluate Formula 

## 9) Maximum Possible Data Rate over Channel Formula

Formula

$$C = 2 \cdot B \cdot \log_2 \left( 1 + \left( \frac{P_{\text{av}}}{P_{\text{an}}} \right) \right)$$

Example with Units

$$5.6653 \text{ b/s} = 2 \cdot 2.2 \text{ Hz} \cdot \log_2 \left( 1 + \left( \frac{2.45 \text{ W}}{1.7 \text{ W}} \right) \right)$$

Evaluate Formula 

## 10) Number of Bits in Error Formula

Formula

$$N_e = \text{BER} \cdot N_t$$

Example

$$3.05 = 0.61 \cdot 5$$

Evaluate Formula 

## 11) Number of Bits per Symbol Formula

Formula

$$B_{\text{sym}} = \frac{B_{\text{rate}}}{S_{\text{rate}}}$$

Example with Units

$$8.046 \text{ bits} = \frac{7 \text{ b/s}}{0.87 \text{ Sym/s}}$$

Evaluate Formula 

## 12) Number of Symbol in Error Formula

Formula

$$N_{\text{se}} = \text{SER} \cdot N_{\text{st}}$$

Example

$$18 = 2 \cdot 9$$

Evaluate Formula 

## 13) Symbol Error Rate Formula

Formula

$$\text{SER} = \frac{N_{\text{se}}}{N_{\text{st}}}$$

Example

$$2 = \frac{18}{9}$$

Evaluate Formula 

## 14) Symbol Rate given Bit Rate Formula

Formula

$$S_{\text{rate}} = \frac{B_{\text{rate}}}{B_{\text{sym}}}$$

Example with Units

$$0.875 \text{ Sym/s} = \frac{7 \text{ b/s}}{8 \text{ bits}}$$






Evaluate Formula 



## Variables used in list of Data Transmissions and Error Analysis Formulas above



- **B** Radio Channel Bandwidth (Hertz)
- **B<sub>rate</sub>** Bit Rate (Bit Per Second)
- **B<sub>sym</sub>** Number of Bits per Symbol (Bit)
- **BER** Bit Error Rate
- **C** Channel Capacity (Bit Per Second)
- **N<sub>e</sub>** Number of Bits in Error
- **N<sub>se</sub>** Number of Symbols in Error
- **N<sub>st</sub>** Number of Symbols Transmitted
- **N<sub>t</sub>** Total Number of Bits Transmitted
- **P<sub>ab</sub>** Average Signal Power per Bit
- **P<sub>an</sub>** Average Noise Power (Watt)
- **P<sub>av</sub>** Average Signal Power (Watt)
- **P<sub>c</sub>** Average Probability of Correct Decision
- **P<sub>e</sub>** Average Probability of Error
- **S<sub>rate</sub>** Symbol Rate (Symbols per Second)
- **SER** Symbol Error Rate
- **SNR<sub>ab</sub>** Average SNR per Bit
- **SNR<sub>av</sub>** Average SNR

## Constants, Functions, Measurements used in list of Data Transmissions and Error Analysis Formulas above

- **Functions:** **log<sub>2</sub>**, log<sub>2</sub>(Number)  
*The binary logarithm (or log base 2) is the power to which the number 2 must be raised to obtain the value n.*
- **Measurement: Power** in Watt (W)  
*Power Unit Conversion* 
- **Measurement: Frequency** in Hertz (Hz)  
*Frequency Unit Conversion* 
- **Measurement: Data Storage** in Bit (bits)  
*Data Storage Unit Conversion* 
- **Measurement: Bandwidth** in Bit Per Second (b/s)  
*Bandwidth Unit Conversion* 
- **Measurement: Symbol Rate** in Symbols per Second (Sym/s)  
*Symbol Rate Unit Conversion* 



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