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# Information Theory And Coding Formulas

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# List of 15 Information Theory And Coding Formulas

## Information Theory And Coding

### Continuous Channels

#### 1) Amount of Information

$$\text{fx } I = \log_2 \left( \frac{1}{P_k} \right)$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2\_img.jpg\)](#)

$$\text{ex } 2\text{bits} = \log_2 \left( \frac{1}{0.25} \right)$$

#### 2) Channel Capacity

$$\text{fx } C = B \cdot \log_2(1 + \text{SNR})$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa\_img.jpg\)](#)

$$\text{ex } 14.93388\text{b/s} = 3.4\text{Hz} \cdot \log_2(1 + 20\text{dB})$$

#### 3) Data Transfer

$$\text{fx } D = \frac{F_s \cdot 8}{T}$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d\_img.jpg\)](#)

$$\text{ex } 36.36364\text{s} = \frac{5\text{bits} \cdot 8}{1.1\text{b/s}}$$



#### 4) Information Rate

$$fx \quad R = r_s \cdot H[S]$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 1800b/s = 1000b/s \cdot 1.8b/s$$

#### 5) Maximum Entropy

$$fx \quad H[S]_{\max} = \log_2(q)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 4bits = \log_2(16)$$

#### 6) Noise Power of Gaussian Channel

$$fx \quad N_o = 2 \cdot P_{SD} \cdot B$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 8.2E^{-22}pW = 2 \cdot 1.2e10 \cdot 3.4Hz$$

#### 7) Noise Power Spectral Density of Gaussian Channel

$$fx \quad P_{SD} = \frac{2 \cdot B}{N_o}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$ex \quad 1.2E^{-10} = \frac{2 \cdot 3.4Hz}{578pW}$$

#### 8) Nth Extension Entropy

$$fx \quad (H[S^n]) = n \cdot H[S]$$

[Open Calculator !\[\]\(aff7c69c44a5e015f18c35867ef3f5c3\_img.jpg\)](#)

$$ex \quad 12.6 = 7 \cdot 1.8b/s$$



## 9) Nyquist Rate

$$f_x \quad N_r = 2 \cdot B$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 6.8\text{Hz} = 2 \cdot 3.4\text{Hz}$$

## 10) Symbol Rate

$$f_x \quad r_s = \frac{R}{H[S]}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 1000\text{b/s} = \frac{1800\text{b/s}}{1.8\text{b/s}}$$

## Source Coding

### 11) Coding Efficiency

$$f_x \quad \eta_c = \left( \frac{H_r[S]}{L \cdot \log_2(D_s)} \right) \cdot 100$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a\_img.jpg\)](#)

$$ex \quad 0.080991 = \left( \frac{1.13}{420 \cdot \log_2(10)} \right) \cdot 100$$

### 12) Coding Redundancy

$$f_x \quad R_{\eta_c} = \left( 1 - \left( \frac{H_r[S]}{L \cdot \log_2(D_s)} \right) \right) \cdot 100$$

[Open Calculator !\[\]\(c1168d6a8b365d11e842ece304635fa7\_img.jpg\)](#)

$$ex \quad 99.91901 = \left( 1 - \left( \frac{1.13}{420 \cdot \log_2(10)} \right) \right) \cdot 100$$



13) R-Ary Entropy 

$$\text{fx } (H_r[S]) = \frac{H[S]}{\log_2(r)}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$\text{ex } 1.135674 = \frac{1.8\text{b/s}}{\log_2(3)}$$

14) Source Efficiency 

$$\text{fx } \eta_s = \left( \frac{H[S]}{H[S]_{\max}} \right) \cdot 100$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$\text{ex } 45 = \left( \frac{1.8\text{b/s}}{4\text{bits}} \right) \cdot 100$$

15) Source Redundancy 

$$\text{fx } R_{\eta_s} = (1 - \eta) \cdot 100$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$\text{ex } 30 = (1 - 0.7) \cdot 100$$



## Variables Used







- **B** Channel Bandwidth (Hertz)
- **C** Channel Capacity (Bit per Second)
- **D** Data Transfer (Second)
- **D<sub>S</sub>** Number of Symbols in Encoding Alphabet
- **F<sub>S</sub>** File Size (Bit)
- **H<sub>r</sub>[S]** R-Ary Entropy
- **H[S<sup>n</sup>]** Nth Extension Entropy
- **H[S]** Entropy (Bit per Second)
- **H[S]<sub>max</sub>** Maximum Entropy (Bit)
- **I** Amount of Information (Bit)
- **L** Average Length
- **n** Nth Source
- **N<sub>0</sub>** Noise Power of Gaussian Channel (Picowatt)
- **N<sub>r</sub>** Nyquist Rate (Hertz)
- **P<sub>k</sub>** Probability of Occurrence
- **P<sub>SD</sub>** Noise Power Spectral Density
- **q** Total Symbol
- **r** Symbols
- **R** Information Rate (Bit per Second)
- **r<sub>s</sub>** Symbol Rate (Bit per Second)
- **R<sub>ηc</sub>** Code Redundancy
- **R<sub>ηs</sub>** Source Redundancy



- **SNR** Signal to Noise Ratio (Decibel)
- **T** Transfer Speed (Bit per Second)
- $\eta$  Efficiency
- $\eta_c$  Code Efficiency
- $\eta_s$  Source Efficiency



## Constants, Functions, Measurements used

- **Function:** **log2**,  $\log_2(\text{Number})$   
*Binary logarithm function (base 2)*
- **Measurement:** **Time** in Second (s)  
*Time Unit Conversion* 
- **Measurement:** **Power** in Picowatt (pW)  
*Power Unit Conversion* 
- **Measurement:** **Frequency** in Hertz (Hz)  
*Frequency Unit Conversion* 
- **Measurement:** **Data Storage** in Bit (bits)  
*Data Storage Unit Conversion* 
- **Measurement:** **Data Transfer** in Bit per Second (b/s)  
*Data Transfer Unit Conversion* 
- **Measurement:** **Sound** in Decibel (dB)  
*Sound Unit Conversion* 





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