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Fundamentals of Analog Communications Formulas

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List of 24 Fundamentals of Analog Communications Formulas

Fundamentals of Analog Communications

1) Amplitude of Carrier Signal

$$\text{fx } A_c = \frac{A_{\max} + A_{\min}}{2}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 17\text{V} = \frac{19.2032\text{V} + 14.7968\text{V}}{2}$$

2) Bandwidth of Tuned Circuit

$$\text{fx } \text{BW}_{\text{tuned}} = \frac{\omega_r}{Q_{tc}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 3.491124\text{Hz} = \frac{11.8\text{Hz}}{3.38}$$

3) Carrier Frequency

$$\text{fx } f_c = \frac{\omega_m}{2 \cdot \pi}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 50.13381\text{Hz} = \frac{315\text{rad/s}}{2 \cdot \pi}$$



4) Carrier Power 

$$fx \quad P_c = \frac{A_c^2}{2 \cdot R}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)


$$ex \quad 1.153693W = \frac{(17V)^2}{2 \cdot 125.25\Omega}$$

5) Crest Factor 

$$fx \quad CF = \frac{X_{peak}}{X_{rms}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)


$$ex \quad 3.913043 = \frac{90V}{23V}$$

6) Cyclic Frequency of Superheterodyne Receiver 

$$fx \quad f_{cyc} = \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 0.038488Hz = \frac{1}{2 \cdot \pi \cdot \sqrt{5.7H \cdot 3F}}$$

7) Deviation Ratio 

$$fx \quad D = \frac{\Delta f_m}{f_m}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 0.05 = \frac{750Hz}{15000Hz}$$



8) Figure of Merit of Superheterodyne Receiver 

$$fx \quad FOM = \frac{1}{F}$$

Open Calculator 


$$ex \quad 0.04 = \frac{1}{25}$$

9) Image Frequency 

$$fx \quad f_{img} = F_{RF} + (2 \cdot f_{im})$$

Open Calculator 

$$ex \quad 195\text{Hz} = 55\text{Hz} + (2 \cdot 70\text{Hz})$$

10) Image Frequency Rejection Ratio of Superheterodyne Receiver 

$$fx \quad IMRR = \sqrt{1 + (Q)^2 \cdot (cf)^2}$$

Open Calculator 

$$ex \quad 1.21189 = \sqrt{1 + (0.21)^2 \cdot (3.26)^2}$$

11) Image Rejection Ratio 

$$fx \quad \rho = \left(\frac{f_{img}}{F_{RF}} \right) - \left(\frac{F_{RF}}{f_{img}} \right)$$

Open Calculator 

$$ex \quad 3.263403\text{dB} = \left(\frac{195\text{Hz}}{55\text{Hz}} \right) - \left(\frac{55\text{Hz}}{195\text{Hz}} \right)$$



12) Intermediate Frequency

$$fx \quad f_{im} = (f_{lo} - F_{RF})$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 70Hz = (125Hz - 55Hz)$$

13) Maximum Amplitude

$$fx \quad A_{max} = A_c \cdot (1 + \mu^2)$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 19.2032V = 17V \cdot (1 + (0.36)^2)$$

14) Minimum Amplitude

$$fx \quad A_{min} = A_c \cdot (1 - \mu^2)$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 14.7968V = 17V \cdot (1 - (0.36)^2)$$

15) Modulation Index

$$fx \quad \mu = \frac{A_m}{A_c}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.36 = \frac{6.12V}{17V}$$



16) Modulation Index with respect to Amplitude Sensitivity

$$fx \quad \mu = K_a \cdot A_m$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 0.306 = 0.05 \cdot 6.12V$$

17) Modulation Index with respect to Maximum and Minimum Amplitude

$$fx \quad \mu = \frac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 0.1296 = \frac{19.2032V - 14.7968V}{19.2032V + 14.7968V}$$

18) Modulation Index with respect to Power

$$fx \quad \mu = \sqrt{2 \cdot \left(\left(\frac{P_T}{P_{c(\text{avg})}} \right) - 1 \right)}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$ex \quad 0.367527 = \sqrt{2 \cdot \left(\left(\frac{4.9W}{4.59W} \right) - 1 \right)}$$

19) Noise Figure of Superheterodyne Receiver

$$fx \quad F = \frac{1}{\text{FOM}}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$ex \quad 25 = \frac{1}{0.04}$$



20) Phase Constant of Distortion Less Line 

$$\text{fx } \beta = \omega \cdot \sqrt{L \cdot C}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)


$$\text{ex } 8.270429 = 2\text{rad/s} \cdot \sqrt{5.7\text{H} \cdot 3\text{F}}$$

21) Phase Velocity of Distortion Less Line 

$$\text{fx } V_p = \frac{1}{\sqrt{L \cdot C}}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$\text{ex } 0.241825\text{m/s} = \frac{1}{\sqrt{5.7\text{H} \cdot 3\text{F}}}$$

22) Quality Factor of Tuned Circuit 

$$\text{fx } Q_{tc} = \frac{2 \cdot \pi \cdot \omega_r \cdot L}{R}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$\text{ex } 3.374108 = \frac{2 \cdot \pi \cdot 11.8\text{Hz} \cdot 5.7\text{H}}{125.25\Omega}$$

23) Rejection Ratio 

$$\text{fx } \alpha = \sqrt{1 + (Q_{tc}^2 \cdot \rho^2)}$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19_img.jpg\)](#)

$$\text{ex } 11.07553\text{dB} = \sqrt{1 + ((3.38)^2 \cdot (3.2634\text{dB})^2)}$$



24) Transmission Efficiency with respect to Modulation Index

[Open Calculator !\[\]\(3d8c13c92b853674f749aac6fa869926_img.jpg\)](#)

$$\text{fx } \eta_{\text{am}} = \frac{\mu^2}{2 + \mu^2}$$

$$\text{ex } 0.060856 = \frac{(0.36)^2}{2 + (0.36)^2}$$



Variables Used











- A_c Amplitude of Carrier Signal (Volt)
- A_m Amplitude of Modulating Signal (Volt)
- A_{max} Maximum Amplitude of AM Wave (Volt)
- A_{min} Minimum Amplitude of AM Wave (Volt)
- BW_{tuned} Tuned Circuit Bandwidth (Hertz)
- C Capacitance (Farad)
- cf Coupling Factor
- CF Crest Factor
- D Deviation Ratio
- F Noise Figure
- f_c Carrier Frequency (Hertz)
- f_{cyc} Cyclic Frequency (Hertz)
- f_{im} Intermediate Frequency (Hertz)
- f_{img} Image Frequency (Hertz)
- f_{lo} Local Oscillation Frequency (Hertz)
- f_m Maximum Modulating Frequency (Hertz)
- F_{RF} Received Signal Frequency (Hertz)
- FOM Figure of Merit
- $IMRR$ Image Frequency Rejection Ratio
- K_a Amplitude Sensitivity of Modulator
- L Inductance (Henry)
- P_c Carrier Power (Watt)



- $P_{c(avg)}$ Average Carrier Power of AM Wave (Watt)
- P_T Average Total Power of AM Wave (Watt)
- Q Quality Factor
- Q_{tc} Quality Factor of Tuned Circuit
- R Resistance (Ohm)
- V_p Phase Velocity of Distortion Less Line (Meter per Second)
- X_{peak} Peak Value of Signal (Volt)
- X_{rms} RMS Value of Signal (Volt)
- α Rejection Ratio (Decibel)
- β Phase Constant of Distortion Less Line
- Δf_m Maximum Frequency Deviation (Hertz)
- η_{am} Transmission Efficiency of AM Wave
- μ Modulation Index
- ρ Image Rejection Ratio (Decibel)
- ω Angular Velocity (Radian per Second)
- ω_m Angular Frequency of Modulating Signal (Radian per Second)
- ω_r Resonant Frequency (Hertz)







Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Power** in Watt (W)
Power Unit Conversion 
- **Measurement:** **Noise** in Decibel (dB)
Noise Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Capacitance** in Farad (F)
Capacitance Unit Conversion 
- **Measurement:** **Electric Resistance** in Ohm (Ω)
Electric Resistance Unit Conversion 
- **Measurement:** **Inductance** in Henry (H)
Inductance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s)
Angular Velocity Unit Conversion 
- **Measurement:** **Angular Frequency** in Radian per Second (rad/s)
Angular Frequency Unit Conversion 



Check other formula lists

- [Amplitude Modulation Characteristics Formulas](#) 
- [Analog Noise and Power Analysis Formulas](#) 
- [Frequency Modulation Formulas](#) 
- [Fundamentals of Analog Communications Formulas](#) 
- [Sideband and Frequency Modulation Formulas](#) 

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