Important Analog Noise and Power Analysis Formulas PDF

Formulas
Examples
with Units

List of 14
Important Analog Noise and Power Analysis Formulas

1) Equivalent Noise Temperature Formula

Evaluate Formula

Formula

$$T = \left(N_f - 1 \right) \cdot T_o$$

Example with Units

$$363.743\,\text{K} = \left(2.22 - 1 \right) \cdot 298.15\,\text{K}$$

2) Mean Square Value of Shot Noise Formula

Evaluate Formula

Formula

$$i_{shot} = \sqrt{2 \cdot \left(i_t + i_o \right) \cdot [\text{Charge-e}] \cdot BW_{en}}$$

Example with Units

$$6.4\text{E-}6\,\text{mA} = \sqrt{2 \cdot \left(8.25\,\text{mA} + 126\,\text{mA} \right) \cdot 1.6\text{E-}19\,\text{C} \cdot 960\,\text{Hz}}$$

3) Noise Factor Formula

Evaluate Formula

Formula

$$N_f = \frac{P_{si} \cdot P_{no}}{P_{so} \cdot P_{ni}}$$

Example with Units

$$2.2222 = \frac{25\,\text{W} \cdot 24\,\text{W}}{15\,\text{W} \cdot 18\,\text{W}}$$

4) Noise Power at Output of Amplifier Formula

Evaluate Formula

Formula

$$P_{no} = P_{ni} \cdot N_f \cdot P_{ng}$$

Example with Units

$$23.976\,\text{W} = 18\,\text{W} \cdot 2.22 \cdot 0.6$$

5) Noise Power Gain Formula

Evaluate Formula

Formula

$$P_{ng} = \frac{P_{so}}{P_{si}}$$

Example with Units

$$0.6 = \frac{15\,\text{W}}{25\,\text{W}}$$

6) Output SNR Formula

Evaluate Formula

Formula

$$SNR = \log10\left(\frac{P_s}{P_n}\right)$$

Example with Units

$$0.6021\,\text{dB} = \log10\left(\frac{8\,\text{W}}{2\,\text{W}}\right)$$

7) Power Density Spectrum of Thermal Noise Formula

Evaluate Formula

Formula

$$P_{dt} = 2 \cdot [BoltZ] \cdot T \cdot R_{ns}$$

Example with Units

$$1.2\text{E-}20\,\text{W/m}^3 = 2 \cdot 1.4\text{E-}23\,\text{J/K} \cdot 363.74\,\text{K} \cdot 1.23\,\Omega$$

8) Power Spectral Density of White Noise Formula

Evaluate Formula

Formula

$$P_{dw} = [BoltZ] \cdot \frac{T}{2}$$

Example with Units

$$2.5\text{E-}21\,\text{W/m}^3 = 1.4\text{E-}23\,\text{J/K} \cdot \frac{363.74\,\text{K}}{2}$$

9) RMS Noise Voltage Formula

Evaluate Formula

Formula

$$V_{rms} = \sqrt{4 \cdot [BoltZ] \cdot T \cdot BW_n \cdot R_{ns}}$$

Example with Units

$$2.2\text{E-}6\,\text{mV} = \sqrt{4 \cdot 1.4\text{E-}23\,\text{J/K} \cdot 363.74\,\text{K} \cdot 200\,\text{Hz} \cdot 1.23\,\Omega}$$

10) RMS Thermal Noise Current Formula

Evaluate Formula

Formula

$$i_{rms} = \sqrt{4 \cdot [BoltZ] \cdot T \cdot G \cdot BW_n}$$

Example with Units

$$1.6\text{E-}5\,\text{mA} = \sqrt{4 \cdot 1.4\text{E-}23\,\text{J/K} \cdot 363.74\,\text{K} \cdot 60\,\text{℧} \cdot 200\,\text{Hz}}$$

11) SNR for AM Demodulation Formula

Evaluate Formula

Formula

$$SNR_{am} = \left(\frac{\mu^2 \cdot A_{sm}}{1 + \mu^2 \cdot A_{sm}}\right) \cdot SNR$$

Example with Units

$$0.0297\,\text{dB} = \left(\frac{0.36^2 \cdot 0.4}{1 + 0.36^2 \cdot 0.4}\right) \cdot 0.602\,\text{dB}$$

12) SNR for FM System Formula

Evaluate Formula

Formula

$$SNR_{fm} = 3 \cdot D^2 \cdot A_{sm} \cdot SNR$$

Example with Units

$$0.0018\,\text{dB} = 3 \cdot 0.050^2 \cdot 0.4 \cdot 0.602\,\text{dB}$$

13) SNR for PM System Formula

Evaluate Formula

Formula

$$SNR_{pm} = k_p^2 \cdot A_{sm} \cdot SNR$$

Example with Units

$$3.8528\,\text{dB} = 4^2 \cdot 0.4 \cdot 0.602\,\text{dB}$$

14) Thermal Noise Power Formula

Evaluate Formula

Formula

$$P_{tn} = [BoltZ] \cdot T \cdot BW_n$$

Example with Units

$$1\text{E-}18\,\text{W} = 1.4\text{E-}23\,\text{J/K} \cdot 363.74\,\text{K} \cdot 200\,\text{Hz}$$

Variables used in list of Analog Noise and Power Analysis Formulas above

- A_{sm} Amplitude of Message Signal
- BW_{en} Effective Noise Bandwidth *(Hertz)*
- BW_{n} Noise Bandwidth *(Hertz)*
- **D** Deviation Ratio
- **G** Conductance *(Mho)*
- i_{o} Reverse Saturation Current *(Milliampere)*
- i_{rms} RMS Thermal Noise Current *(Milliampere)*
- i_{shot} Mean Square Shot Noise Current *(Milliampere)*
- i_{t} Total Current *(Milliampere)*
- k_{p} Phase Deviation Constant
- N_{f} Noise Factor
- P_{dt} Power Spectral Density of Thermal Noise *(Watt Per Cubic Meter)*
- P_{dw} Power Spectral Density of White Noise *(Watt Per Cubic Meter)*
- P_{n} Noise Power *(Watt)*
- P_{ng} Noise Power Gain
- P_{ni} Noise Power at Input *(Watt)*
- P_{no} Noise Power at Output *(Watt)*
- P_{s} Signal Power *(Watt)*
- P_{si} Signal Power at Input *(Watt)*
- P_{so} Signal Power at Output *(Watt)*
- P_{tn} Thermal Noise Power *(Watt)*
- R_{ns} Noise Resistance *(Ohm)*
- **SNR** Signal to Noise Ratio *(Decibel)*
- SNR_{am} SNR of AM System *(Decibel)*
- SNR_{fm} SNR of FM System *(Decibel)*
- SNR_{pm} SNR of PM System *(Decibel)*
- **T** Temperature *(Kelvin)*
- T_{o} Room Temperature *(Kelvin)*

Constants, Functions, Measurements used in list of Analog Noise and Power Analysis Formulas above

- constant(s): **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- constant(s): **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Functions: **log10**, log10(Number)
  The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Electric Conductance** in Mho (℧)
  Electric Conductance Unit Conversion
- Measurement: **Electric Potential** in Millivolt (mV)
  Electric Potential Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion
- Measurement: **Power Density** in Watt Per Cubic Meter (W/m^3)
  Power Density Unit Conversion

- V_{rms} RMS Noise Voltage *(Millivolt)*
- μ Modulation Index

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