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Parametric Devices Formulas

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List of 13 Parametric Devices Formulas

Parametric Devices

1) Bandwidth of Negative Resistance Parametric Amplifier (NRPA)

Open Calculator

fx $$BW_{NRPA} = \left(\frac{\gamma}{2}\right) \cdot \sqrt{\frac{f_i}{f_s \cdot G_{NRPA}}}$$

ex $$0.02759Hz = \left(\frac{0.19}{2}\right) \cdot \sqrt{\frac{125Hz}{95Hz \cdot 15.6dB}}$$

2) Bandwidth of Parametric Up-Converter

Open Calculator

fx $$BW_{up} = 2 \cdot \gamma \cdot \sqrt{\frac{f_o}{f_s}}$$

ex $$1.201666Hz = 2 \cdot 0.19 \cdot \sqrt{\frac{950Hz}{95Hz}}$$

3) Gain-Degradation Factor

Open Calculator

fx $$GDF = \left(\frac{f_s}{f_o}\right) \cdot G_{up}$$

ex $$0.8 = \left(\frac{95Hz}{950Hz}\right) \cdot 8dB$$

4) Idler Frequency using Pumping Frequency

Open Calculator

fx $f_i = f_p - f_s$

ex $125\text{Hz} = 220\text{Hz} - 95\text{Hz}$

5) Noise Figure of Parametric Up-Converter

Open Calculator

fx $F = 1 + \left(\frac{2 \cdot T_d}{\gamma \cdot Q_{up} \cdot T_0} + \frac{2}{T_0 \cdot (\gamma \cdot Q_{up})^2} \right)$

ex $2.944879\text{dB} = 1 + \left(\frac{2 \cdot 290\text{K}}{0.19 \cdot 5.25 \cdot 300\text{K}} + \frac{2}{300\text{K} \cdot (0.19 \cdot 5.25)^2} \right)$

6) Output Frequency in Up-Convertor

Open Calculator

fx $f_o = \left(\frac{G_{up}}{GDF} \right) \cdot f_s$

ex $950\text{Hz} = \left(\frac{8\text{dB}}{0.8} \right) \cdot 95\text{Hz}$

7) Output Resistance of Signal Generator

Open Calculator

fx $R_g = \frac{G_{NRPA} \cdot f_s \cdot R_{Ts} \cdot R_{Ti} \cdot (1 - \alpha)^2}{4 \cdot f_s \cdot R_i \cdot \alpha}$

ex $33.28\Omega = \frac{15.6\text{dB} \cdot 95\text{Hz} \cdot 7.8\Omega \cdot 10\Omega \cdot (1 - 9)^2}{4 \cdot 95\text{Hz} \cdot 65\Omega \cdot 9}$

8) Power Gain for Parametric Up-Converter

Open Calculator

$$G_{up} = \left(\frac{f_o}{f_s}\right) \cdot GDF$$

$$8dB = \left(\frac{950Hz}{95Hz}\right) \cdot 0.8$$

9) Power Gain of Demodulator

Open Calculator

$$G_{dm} = \frac{f_s}{f_p + f_s}$$

$$0.301587dB = \frac{95Hz}{220Hz + 95Hz}$$

10) Power Gain of Down-Converter

Open Calculator

$$G_{down} = \frac{4 \cdot f_i \cdot R_i \cdot R_g \cdot \alpha}{f_s \cdot R_{Ts} \cdot R_{Ti} \cdot (1 - \alpha)^2}$$

$$20.35362dB = \frac{4 \cdot 125Hz \cdot 65\Omega \cdot 33\Omega \cdot 9}{95Hz \cdot 7.8\Omega \cdot 10\Omega \cdot (1 - 9)^2}$$

11) Power Gain of Modulator

Open Calculator

$$G_m = \frac{f_p + f_s}{f_s}$$

$$3.315789dB = \frac{220Hz + 95Hz}{95Hz}$$

12) Pumping Frequency using Demodulator Gain

Open Calculator

fx $$f_p = \left(\frac{f_s}{G_{dm}} \right) - f_s$$

ex $$221.6667\text{Hz} = \left(\frac{95\text{Hz}}{0.3\text{dB}} \right) - 95\text{Hz}$$

13) Signal frequency

Open Calculator

fx $$f_s = \frac{f_p}{G_m - 1}$$

ex $$95.0324\text{Hz} = \frac{220\text{Hz}}{3.315\text{dB} - 1}$$

Variables Used

- BW_{NRPA} Bandwidth of NRPA *(Hertz)*
- BW_{up} Bandwidth of Up-Converter *(Hertz)*
- F Noise Figure of Up-Converter *(Decibel)*
- f_i Idler Frequency *(Hertz)*
- f_o Output Frequency *(Hertz)*
- f_p Pumping Frequency *(Hertz)*
- f_s Signal Frequency *(Hertz)*
- G_{dm} Power Gain of Demodulator *(Decibel)*
- G_{down} Power Gain Down-Converter *(Decibel)*
- G_m Power Gain of Modulator *(Decibel)*
- G_{NRPA} Gain of NRPA *(Decibel)*
- G_{up} Power Gain for Up-Converter *(Decibel)*
- GDF Gain Degradation Factor
- Q_{up} Q-Factor of Up-Converter
- R_g Output Resistance of Signal Generator *(Ohm)*
- R_i Output Resistance of Idler Generator *(Ohm)*
- R_{Ti} Total Series Resistance at Idler Frequency *(Ohm)*
- R_{Ts} Total Series Resistance at Signal Frequency *(Ohm)*
- T_0 Ambient Temperature *(Kelvin)*
- T_d Diode Temperature *(Kelvin)*
- α Ratio Negative Resistance to Series Resistance

- γ Coupling Coefficient

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Noise** in Decibel (dB)
  Noise Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion

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