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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 !\[\]\(339a16584d5da0f0a3ca4e9ec17bf6a1_img.jpg\)](#)

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

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

2) Bandwidth of Parametric Up-Converter

[Open Calculator !\[\]\(6059a5aa8b4ca7bb793408023d6c6e42_img.jpg\)](#)

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

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

3) Gain-Degradation Factor

[Open Calculator !\[\]\(e3275251d0893157c3584e20c81dc3ba_img.jpg\)](#)

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

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



4) Idler Frequency using Pumping Frequency

$$\text{fx } f_i = f_p - f_s$$

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

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

5) Noise Figure of Parametric Up-Converter

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

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

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

6) Output Frequency in Up-Convertor

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

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

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

7) Output Resistance of Signal Generator

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

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

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



8) Power Gain for Parametric Up-Converter

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

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

9) Power Gain of Demodulator

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

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

10) Power Gain of Down-Converter

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

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

11) Power Gain of Modulator

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

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



12) Pumping Frequency using Demodulator Gain

[Open Calculator !\[\]\(bd1a142de767a21e5362c595f844a4ff_img.jpg\)](#)

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

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

13) Signal frequency

[Open Calculator !\[\]\(830769b31eeeaca920791081939ff8ba_img.jpg\)](#)

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

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



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



- **Υ 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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