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APPLICATION NOTE 5059

## Thermal Noise Calculator Tutorial

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*Abstract: The Thermal Noise Calculator (TNC) aids in the analysis of thermal noise found in resistors and other noise sources. The program is for use with an HP® 50g calculator or free PC emulator.*

### Introduction

Steve Edwards, an experienced analog design engineer, has written several calculators to automate repetitive tasks. These tools are being shared to help other analog design engineers who select, specify, and characterize analog circuits. We will summarize the functionality of one such tool, the Thermal Noise Calculator.

### Thermal Noise Calculator

The Thermal Noise Calculator (TNC) is a program written for the HP 50g calculator that aids in the analysis of thermal noise found in resistors and other noise sources. TNC finds the noise voltage generated by any device if its white-noise spectral density and 1/f corner frequency are known. Each parameter can be entered or found. TNC can also be run on a PC using the free program HPUUserEdit 5.4, found at [www.hpcalc.org](http://www.hpcalc.org), or on [Steve's Analog Design Calculator](#) page on Maxim's website.

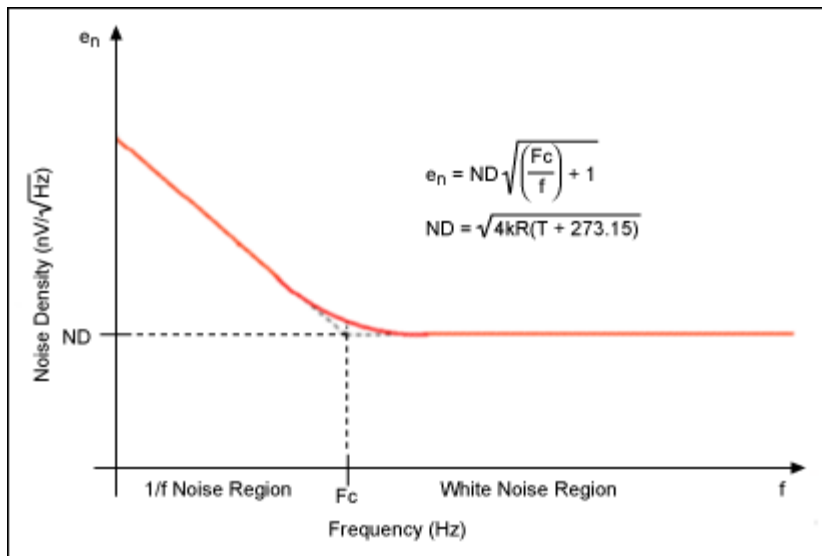


Figure 1. Spectral noise density.

The format of the TNC User's Guide (available as part of the TNC program package) provides instructions for the calculator's use, the theory and equations behind the issue, and most importantly, a practical example of its use in circuit design and analysis.

Seven parameters can be entered or found:

1. Noise Voltage,  $V_n$ , in  $\mu\text{V}_{\text{PP}}$  or  $\mu\text{V}_{\text{rms}}$
2. White-Noise Spectral Density,  $ND$ , in  $\text{nV}/\sqrt{\text{Hz}}$
3. Johnson Resistance,  $R$ , in  $\Omega$
4. Temperature,  $T$ , in  $^{\circ}\text{C}$

5. Upper Frequency, Fh, in Hz
6. Lower frequency, Fl, in Hz
7. 1/f Corner Frequency, Fc, in Hz

TNC finds any parameter as a function of the others, making it useful for both design and analysis. These parameters appear in TNC as shown below:

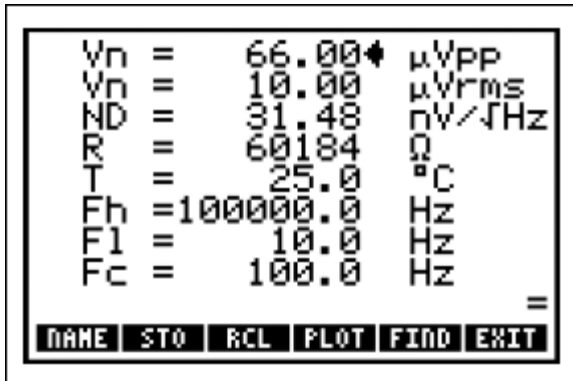


Figure 2. The Thermal Noise Calculator display.

The user's guide tutorial details the types of noise (white, pink, and the thermal noise in resistors) and how it is calculated. The practical example uses TNC to estimate the output noise voltage of the [MAX6143](#) 10V series voltage reference for use in an audio application. The example takes us from entering the data, through solving and finding a converter, and provides quick ways to explore alternative accuracy parts.

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#### Related Parts

[MAX6143](#) High-Precision Voltage Reference with Temperature -- [Free Samples](#)  
Sensor

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