Ratiometric Tolerances

For integrated circuits, monolithic resistors are toleranced in terms of ratios, since the ratio tolerances are much smaller than the tolerances of the individual resistors, which can be as high as ±30%.

One method of tolerancing ratios is best illustrated by an example. Suppose two resistors R1 and R2 have a tolerance of Tr = 0.3 and a ratio tracking tolerance Ta = 0.05 with Ra = R1/R2. Since $\mathrm{Tx}\left(2\cdot\mathrm{rand}-1\right)+1$ can vary from 1 - Tx to 1 + Tx, (0 < rand < 1) we assign a random tolerance multiplier of $\mathrm{Ta}\cdot\left(2\cdot\mathrm{rand}-1\right)+1$ to the ratio, We assign a random tolerance multiplier of $\mathrm{Tr}\cdot\left(2\cdot\mathrm{rand}-1\right)+1$ to R2. To find R1 we use R1 = Ra·R2. A small percentage of the time this will result in a multiplier of > 1.3, and hence is "illegal". Maximum tolerance value for R1 could be Tr(max) = (1.05)(1.3) = 1.365. Thus an if statement must be included to reject values for Tr(max) > 1.3.

The output of M-file trackratio.m and listing is given below. Note the max and min values of the ratio, R(3,1) and R(3,2) in the array R below.

```
R =
   1.2983    0.7006
   1.2929    0.7032
   1.0498    0.9501
k =
     1000
»
```

```
% File trackratio.m
clear;clc;
% assumes resistor values are unity
Tr=0.3;Ta=0.05;
N=1000;
k=1;
while k < N
   R2=Tr*(2*rand-1)+1; % denominator of ratio
   Ra=Ta*(2*rand-1)+1;
   R1=R2*Ra; % numerator of ratio
   if R1>1-Tr & R1<1+Tr % check for "legal" values
      Rd(k)=R2; % denominator
      Rn(k)=R1; % numerator
      Rr(k)=Rn(k)/Rd(k);
      k=k+1;
   end
end
Rnmax=max(Rn);Rdmax=max(Rd);
Rnmin=min(Rn);Rdmin=min(Rd);
Rrmax=max(Rr);Rrmin=min(Rr);
R=[Rnmax Rnmin;Rdmax Rdmin;Rrmax Rrmin]
k
```