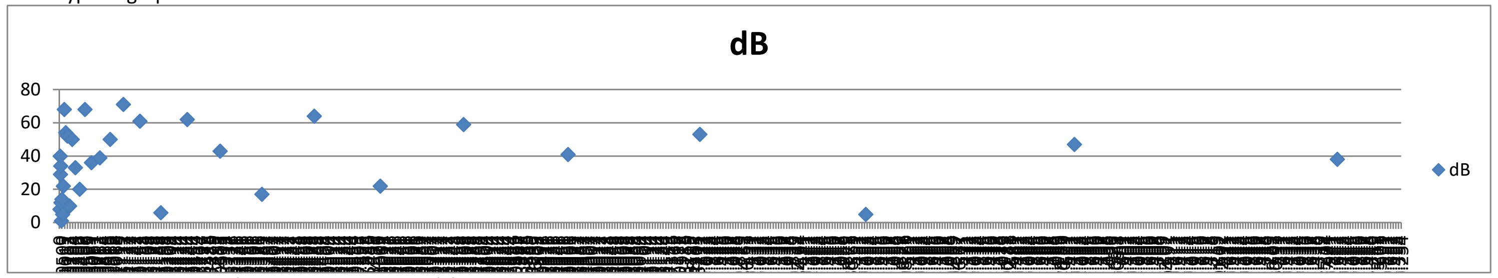
Octave and 1/3 Octave Filters

Say, a sample data is as below:-

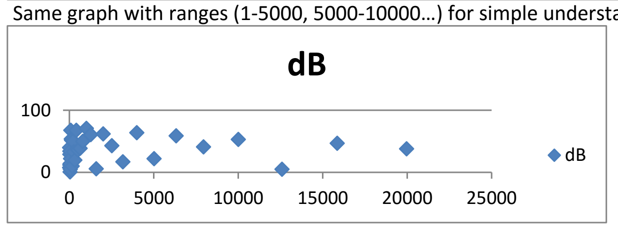
n	10^n freq	dB
1	10	8
1.1	12.58925412	40
1.2	15.84893192	29
1.3	19.95262315	34
1.4	25.11886432	12
1.5	31.6227766	1
1.6	39.81071706	14
1.7	50.11872336	5
1.8	63.09573445	22
1.9	79.43282347	68
2	100	54
2.1	125.8925412	52
2.2	158.4893192	10
2.3	199.5262315	50
2.4	251.1886432	33
2.5	316.227766	20
2.6	398.1071706	68
2.7	501.1872336	36
2.8	630.9573445	39
2.9	794.3282347	50
3	1000	71
3.1	1258.925412	61
3.2	1584.893192	6
3.3	1995.262315	62
3.4	2511.886432	43
3.5	3162.27766	17
3.6	3981.071706	64
3.7	5011.872336	22
3.8	6309.573445	59
3.9	7943.282347	41
4	10000	53
4.1	12589.25412	5
4.2	15848.93192	47
4.3	19952.62315	38

yellow fill = audible
red font = octave central freq
blue font = 1/3 octave central freq

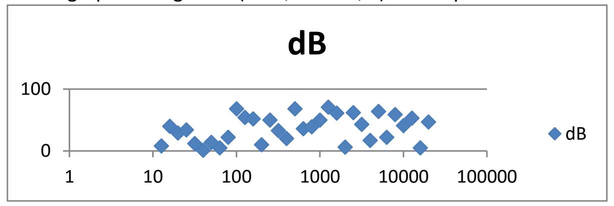
One Type of graph



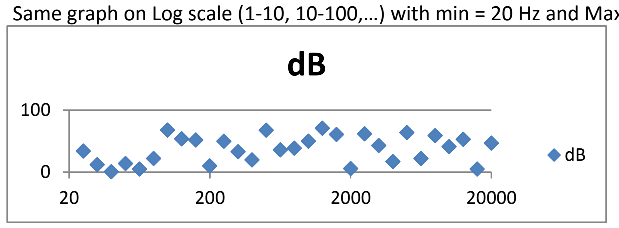
Same graph with ranges (1-5000, 5000-10000...) for simple understanding



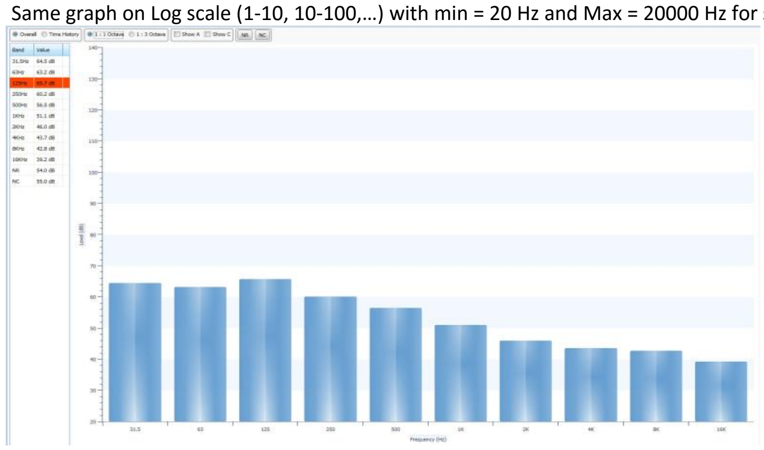
Same graph on Log scale (1-10, 10-100,...) for simpler understanding



Same graph on Log scale (1-10, 10-100,...) with min = 20 Hz and Max = 20000 Hz for simpler noise understanding



Same graph on Log scale (1-10, 10-100,...) with min = 20 Hz and Max = 20000 Hz for simpler noise understanding



But here, no. of divisions = 10
i.e. 10 equally spaced ranges
on log scale = OCTAVE

Why the word 'octave'?
Coz for each band
max= 2*min

and GP with common ratio 2
is called octave (music)

Sounds of same octave
seem similar to ear

Octave band – oct. filter

$$f_1 = \frac{f_2}{2} = 0.5 \cdot f_2$$

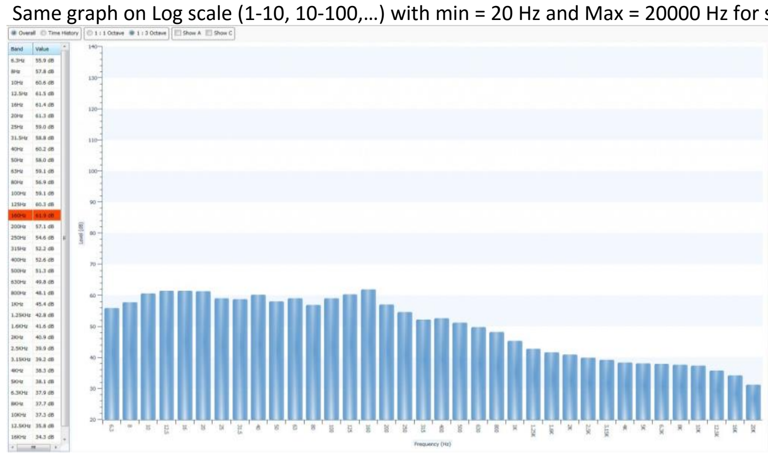
$$f_2 = 2 \cdot f_1$$

$$f_0 = \sqrt{f_1 \cdot f_2} = \sqrt{2} \cdot f_1 = \frac{1}{\sqrt{2}} \cdot f_2$$

$$B = f_2 - f_1 = \left(\sqrt{2} - \frac{1}{\sqrt{2}}\right) \cdot f_0 = 0.707106781 \cdot f_0$$

f_1 = Lower cut-off frequency of the octave or 1/3 octave in Hz
f_2 = Upper cut-off frequency of the octave or 1/3 octave in Hz
f_0 = Center frequency of the octave or 1/3 octave in Hz
B = Bandwidth of the filter $f_2 - f_1$ in Hz

Same graph on Log scale (1-10, 10-100,...) with min = 20 Hz and Max = 20000 Hz for simpler noise understanding



But here, no. of divisions = 30
i.e. 30 equally spaced ranges
on log scale = 1/3 OCTAVE

Why the word 1/3 octave?

Because each octave is further
devided into 3

1/3 Octave band – third oct. filter

$$f_1 = \frac{f_2}{\sqrt[3]{2}} = 0.793700626 \cdot f_2$$

$$f_2 = \sqrt[3]{2} f_1 = 1.25992105 \cdot f_1$$

$$f_0 = \sqrt{f_1 \cdot f_2} = \sqrt[6]{2} \cdot f_1 = \frac{1}{\sqrt[6]{2}} \cdot f_2$$

$$B = \left(\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}}\right) \cdot f_0 = 0,231563329 \cdot f_0$$

blog.prosig.com/2006/02/17/standard-octave-bands/

amit bhola

May 1, 2012 at 4:38 pm

My query meant why 1/3 octave is so common in analysis but not the further octaves? Is there any significant meaning behind 1/3 divisions?

Reply

Dr Colin Mercer **Post author**

May 14, 2012 at 9:05 am

Amit

The origin of 1/3 octaves being so popular is that in a general sense they are close in bandwidth to the way our hearing distinguishes between different frequencies. If you ever get into psychoacoustics there is a unit there called a Bark whose bandwidth is similar to 1/3 octaves.

That is in an approximate sense 1/3 octaves match our hearing.

Reply

Yulik Yagudin

May 21, 2012 at 5:25 am

I'd say that this system also directly refers to a musical scale. In a equal tempered chromatic scale the smallest step – a semitone – is exactly a 1/12 octave. So 1/3 octave is equal to a major third.