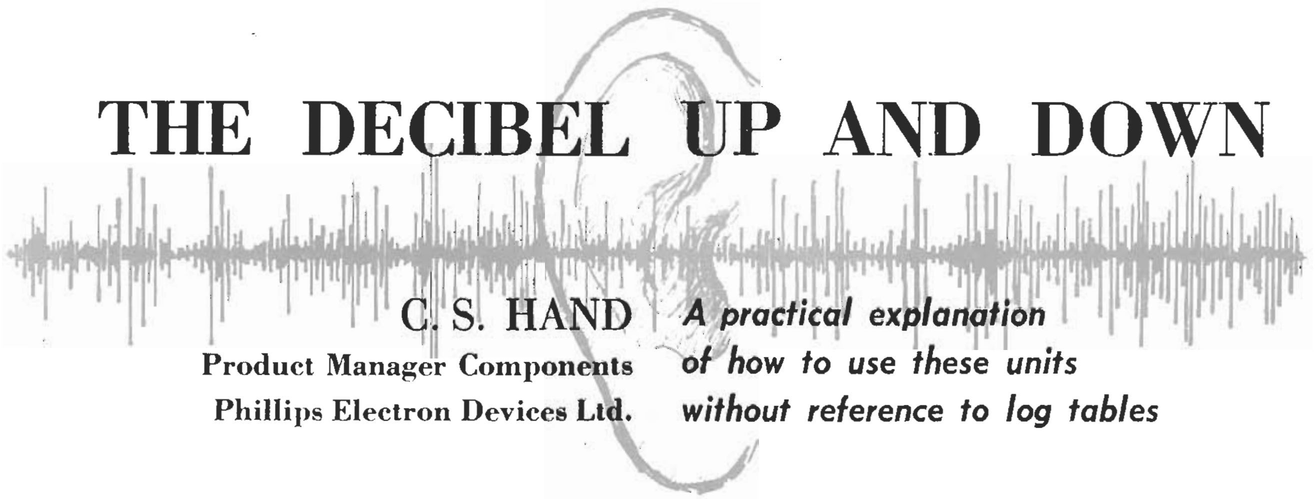

THE DECIBEL UP AND DOWN

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A practical explanation of how to use these units without reference to log tables

There was a time when most of us could get by without bothering too much about decibels, but these days even the layman gets them thrust at him when the press starts talking about anti-noise by laws. As for the audiophile, he gets literally snowed under with them when he starts to read the specifications for the latest AM/FM Stereo equipment. So here's the low-down on decibels with most of the math left out.

The first and most important thing to remember is that decibels express a ratio. It may be power, voltage or current, but whatever it is, doesn't mean a thing unless you're told what the reference level is. When advertiser tells you that Floozy washes whiter, your immediate reaction is — Whiter than what? Without something to compare it with, the statement means nothing. In the same way, if you're told an amplifier has 50 db power gain, you have no indication of the actual power capabilities unless you are told what the input level is. If you look at table 1 you'll see that 50 db power gain represents a ratio of 100,000:1. This means that if your rated input is 1 milliwatt, you'll get 100,000 milliwatts, or 100 watts, output. It is very unlikely that if you fed 1 watt into the same amplifier that you'd get 100,000 watts out, and what you did get out would probably be horribly distorted.

The decibel then is a unit which represents the ratio between either two power levels (P2/P1), or two voltage levels (V2/V1), or two current levels (P2/P1). When the ratio is greater than one, the decibels are shown as positive; when the ratio is less than one, the decibels are negative.

With this explanation in mind take a close look at table 1. Power and voltage ratios from one down are shown in the two left hand columns, and from one upwards are shown in the right hand columns. The decibel equivalents are shown in the middle column and are negative for the left side and positive for the right side. Current ratios aren't shown since they are exactly the same as the voltage ratios.

TABLE 1

P2/P1	V2/V1	−db+	P2/P1	V2/V1
1	1	0	1	1
.1	.316	10	10	3.16
.01	.1	20	100	10
.001	.0316	30	1000	31.6
.0001	.01	40	10000	100
.00001	.00316	50	100000	316
.000001	.001	60	1000000	1000
.0000001	.000316	70	10000000	3160
.00000001	.0001	80	100000000	10000

Now you'll be asking why there should be different ratios for power and voltage decibels, and the answer lies in the fact that the relationship between power and voltage involves the square of the voltage; similarly the relationship between power and current involves the square of the current. In the table P2/P1 is always equal to V2/V1 squared for the same db figure.

This relationship between power and voltage, or current, can be illustrated with the help of figure 1. By doubling the voltage the current is doubled and the power is quadrupled. If you now look at table 2, you'll see that a ratio V2/V1 = 2 is 6db, as is also the ratio P2/P1 = 4. So a 6db increase in voltage has given a 6db increase in power.

Going back to Table 1 notice how for each succeeding 10db increase the power ratio increases by ten times on the positive side, and by one tenth on the negative side. For the voltage ratios the increases are by the square root of ten (3.16) or one over the root of ten (0.316) respectively. This compression of large ratios into manageable decibel figures makes them very useful. Nobody is going to write

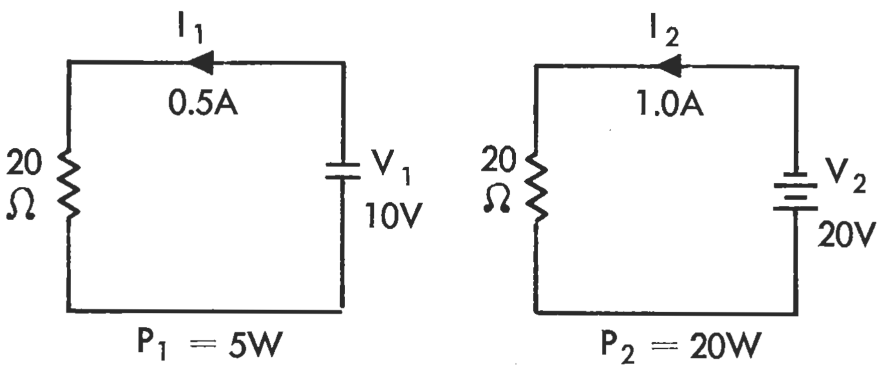

Fig 1 When voltage is doubled, current is also doubled but power is quadrupled.

100,000,000 when he can express it as 80db!

Since decibel figures aren't always quoted in multiples of ten we need some intermediate figures, and that's where table 2 comes in. This table gives you the power and voltage ratios in steps of 1db from 0 to 20db. From this basic table, larger ratios can be quickly and easily calculated, and the method described below will give you an answer to the nearest decibel, which will be sufficient for most reader's requirements.

Using table 1, if you take a power ratio in the range 1 to 10 and multiply it by ten your answer will be in the 10 to 20db range. If you had multiplied by a hundred, instead of ten, you answer would have been in the 20 to 30db range, and so on. Let's illustrate this by taking the ratio 2.5 (4db) from table 2 and multiplying successively by ten.

P1/P2	db
2.5	4
25	14
250	24
2500	34

Now try working backwards from 84db.

The trick is to divide your db figure into two parts: first a multiple of ten which can be read from table 1; second a figure between 1 and 19 to be read from table 2. There is one golden rule to remember: where db figures are added together, the corresponding ratios are multiplied together. For 84db we have:

80db + 4db = 100,000,000 x 2.5 = 250,000,000

Negative decibels are handled in a similar manner.

Let's assume you've measured the ratio of hum power output to maximum power output in your amplifier as 0.000013. Following the same rules:

0.000013 = 0.13 x 0.0001 = −9db −40 = −49db.

(Remember that the number of figures after the decimal point in the two parts must add up to the same number as in the original part, which in the above case was six.)

As a last example try a voltage gain of 79db above one microvolt.

79db = 60 + 19db = 1000 x 8.9 = 8900 uV = 8.9mV.

Note the reference level in the above example. In some cases you may see power ratios quoted in dbm. This is used when the reference level is one milliwatt. Thus a gain of 60dbm means 60db above one milliwatt or one kilowatt.

With a little practice using the tables as shown above, the average reader should quickly become proficient in the use of decibels. After a while, when you get the feel of them, you'll find that you don't even have to calculate a lot of them — you'll know by instinct what their value is. You'll also find the two charts handy for quick reference when you don't need a very accurate figure.

Note:

$10^2 = 100$; $10^3 = 1000$ etc.
$10^{-2} = 0.01$; $10^{-3} = 0.001$ etc

For the benefit of those who like to use log tables the mathematical formulae for decibels are:

Power: db = 10 log P2/P1
Voltage: db = 20 log V2/V1
Current: db = 10 log I^2/I^1

The charts will provide a quick means of determining decibels from a known voltage, current or power ratio. Always work solutions using the figures and chart line of the same colour. If the ratio figure is on the line nearest the chart the answer is in the decibel row nearest the chart.

Example: If you have a voltage (or current) ratio of 6, follow the line up from the bottom till it reaches the diagonal line. By reading the column to the left of this juncture we see we have a gain of slightly more than 15 db.

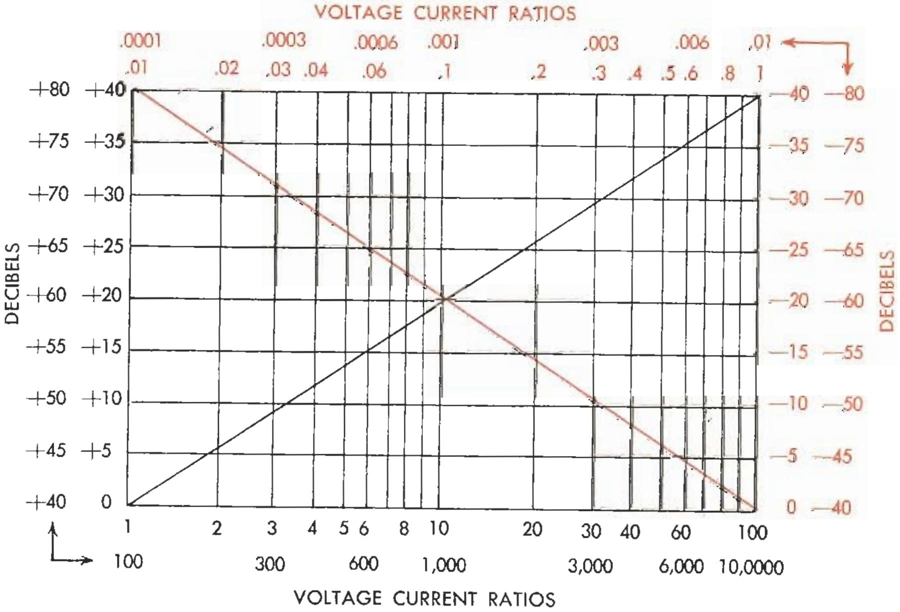

TABLE 2

P2/P1	V2/V1	−db+	P2/P1	V2/V1
1	1	0	1	1
.79	.89	1	1.3	1.1
.63	.79	2	1.6	1.3
.5	.71	3	2	1.4
.4	.63	4	2.5	1.6
.32	.56	5	3.16	1.8
.25	.5	6	4	2
.2	.45	7	5	2.2
.16	.4	8	6.3	2.5
.13	.35	9	7.9	2.8
.1	.316	10	10	3.16
.08	.28	11	13	3.5
.06	.25	12	16	4
.05	.22	13	20	4.5
.04	.2	14	25	5
.032	.18	15	31.6	5.6
.025	.16	16	40	6.3
.02	.14	17	50	7.1
.016	.13	18	63	7.9
.013	.11	19	79	8.9
.01	.1	20	100	10