Keywords: dB gain, dBM, gain calculations, digital pot, digipot, epot, audio potentiometers, DS1802

Mar 03, 2003

APPLICATION NOTE 234

Calculate Ratiometric Outputs of the Log Pot DS1802

Abstract: The DS1802 is a dual audio taper-potentiometer with logarithmic resistive characteristics over the device range. Each potentiometer provides 65 wiper positions with a 1dB increment per step and device mute with at least 90dB of attenuation. The specifications given in this datasheet only refer to decibel measurements. If a designer wishes to calculate these values in ratiometric terms, a conversion is necessary. This application note reviews the conversion from decibel to ratiometric. The formula is given in Excel as an example, for engineers wishing to build Excel tables depicting gain calculations for the DS1802 and other audio potentiometers. While the DS1802 is given as an example, this application note pertains to any audio taper potentiometer.

Overview

The DS1802 is a dual audio taper-potentiometer with logarithmic resistive characteristics over the device range. Each potentiometer provides 65 wiper positions with a 1dB increment per step and device mute with at least 90dB of attenuation. Table 1 shows the dB output as a function of the potentiometer wiper setting.

Table 1. DS1802 Gain (dB) as a Function of Wiper Setting - Resistance Characteristics

POSITION	OUTPUT LEVEL (dB)
0	0
1	-1
2	-2
3	-3
4	-4
5	-5
•	•
•	•
•	•
63	-63
64 (mute)	< -90

This chart only gives the output as a function of dB attenuation with reference to 0dB attenuation at the wiper 0 position. If the ratiometric output is desired, the ratio of the output signal relative to the input signal, a conversion must be made to convert dB to a ratiometric attenuation value.

dB attenuation is defined as 20 X LOG(V_{OUT}/V_{IN}).

The desired ratiometric output is defined as:

$R_L/R_{EE} = R_L/(R_L + R_H) = V_{OUT}/V_{IN}$

with R_H = defined as the high-side of the DS1802, R_L defined as the low side of the DS1802, R_{EE} defined as the end-to-end resistance, and V_{OUT} and V_{IN} defined as the output and input signals, respectively, as shown in **Figure 1**.

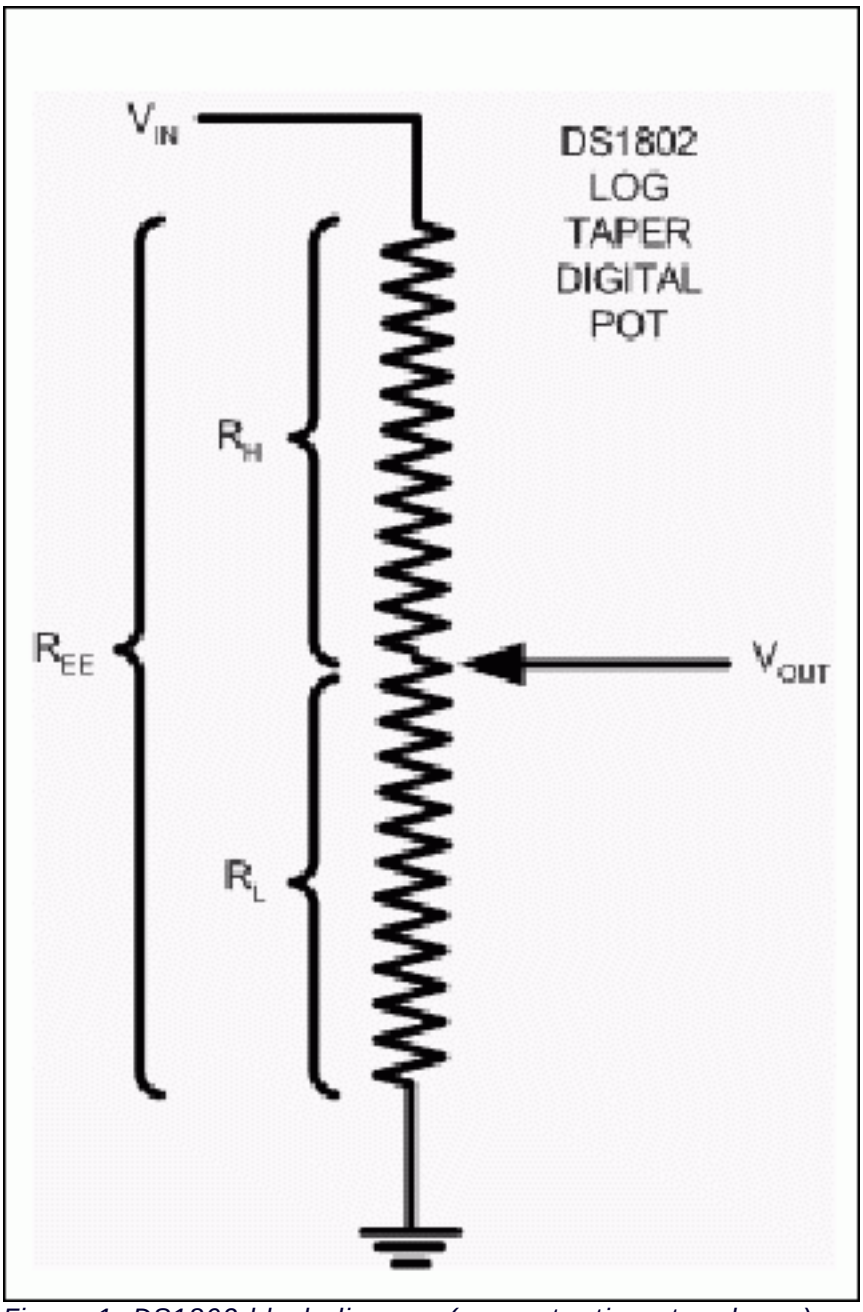

Figure 1. DS1802 block diagram (one potentiometer shown).

If we know the dB attenuation for a given potentiometer setting, we can calculate the ratiometric output by solving for V_{OUT}/V_{IN} or:

the Ratiometric Output = INVERSE LOG_{10}(dB attenuation/20). If one wanted to calculate the output signal ratiometrically as a function of the input in a spreadsheet like Excel, no function for the inverse log function exists. As the INVERSE LOG function of X can be calculated as 10^X, in Excel the power function can be used as follows: = (10)^(dB/20), where dB can be a value stored in another cell in the spreadsheet.

Table 2 below summarizes the ratiometric outputs available for the DS1802. While this example is given for the DS1802, it may be used in calculations to determine the ratiometric output of any LOG potentiometer.

Table 2. Ratiometric output of the DS1802 as a function of dB (Wiper) setting

dB Attenuation	Ratiometric Output	dB Attenuation	Ratiometric Output
0	1.00000	-32	0.02512
-1	0.89125	-33	0.02239
-2	0.79433	-34	0.01995
-3	0.70795	-35	0.01778
-4	0.63096	-36	0.01585
-5	0.56234	-37	0.01413
-6	0.50119	-38	0.01259
-7	0.44668	-39	0.01122
-8	0.39811	-40	0.01000
-9	0.35481	-41	0.00891
-10	0.31623	-42	0.00794
-11	0.28184	-43	0.00708
-12	0.25119	-44	0.00631
-13	0.22387	-45	0.00562
-14	0.19953	-46	0.00501
-15	0.17783	-47	0.00447
-16	0.15849	-48	0.00398
-17	0.14125	-49	0.00355
-18	0.12589	-50	0.00316
-19	0.11220	-51	0.00282
-20	0.10000	-52	0.00251
-21	0.08913	-53	0.00224
-22	0.07943	-54	0.00200
-23	0.07079	-55	0.00178
-24	0.06310	-56	0.00158
-25	0.05623	-57	0.00141
-26	0.05012	-58	0.00126
-27	0.04467	-59	0.00112
-28	0.03981	-60	0.00100
-29	0.03548	-61	0.00089
-30	0.03162	-62	0.00079
-31	0.02818	-63	0.00071
-32	0.02512	-64	MUTE

This ratiometric output can also be expressed as the ration of R_L to R_{EE} ($=R_L/R_{EE}$) so, as an example, the value of R_L at a wiper setting of -21 dB would be 0.08913 x R_{EE}.

More Information

For technical questions and support: http://www.maxim-ic.com/support
For samples: http://www.maxim-ic.com/samples
Other questions and comments: http://www.maxim-ic.com/contact

Related Parts

DS1802: QuickView -- Full (PDF) Data Sheet -- Free Samples

AN234, AN 234, APP234, Appnote234, Appnote 234