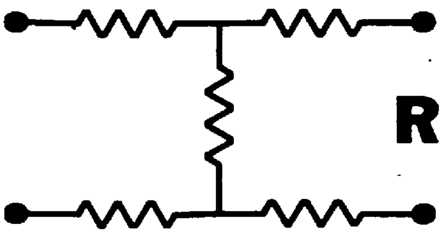
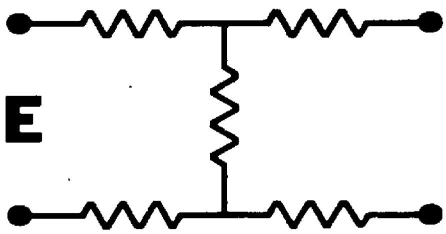
Audio Reference Series



RESISTIVE PADS



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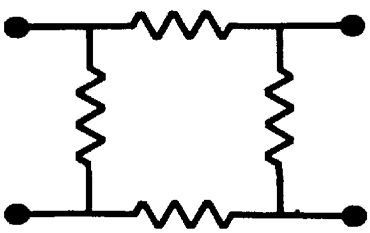

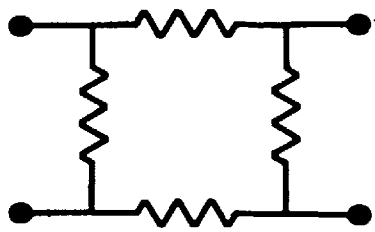

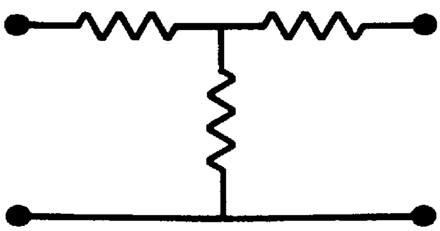

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2d edition

ADJUSTABLE PADS

Examination of the "T & H Pad" charts shows that the shunt resistor (R_1) mostly determines the attenuation of the pad. The input and output resistors mostly establish the impedance of the pad. Large changes in the shunt resistor causes large changes in the attenuation of the pad. This is especially true at higher values of attenuation.

Therefore, a nice, adjustable pad can be made by substituting a potentiometer for the shunt resistor. At low values of attenuation where the series resistors are small, a fixed resistor should be put in series with the potentiometer. Otherwise, when the potentiometer is set to minimum resistance it will nearly short out the source and load termination circuits.

CENTER-TAPPED PADS

Long runs of audio cable such as broadcast loops, long runs between parts of a building, or unusually long mike lines generally use a center-tapped transformer. The center tap is then grounded to reduce hum and noise pick-up.

When an "H" or an "O" pad must be inserted in a center-tapped line the shunt resistor(s) of the pad should be center-tapped and grounded as shown below. In this case the center-tap of the transformer is usually left open.

"H" PAD? "O" PAD?

The "H" and "O" pad and their unbalanced counterparts, the 'T' and "Pi" pad, can be used interchangeably in most studio audio applications. The broadcast and recording industry uses "H" and "T" pads almost exclusively, mostly by tradition.

As the Pad Charts show, at attenuations below about 30 db both "H" and "O" pads use practical, easily available resistance values. However, at higher attenuations the Charts show a big difference. For example, consider a 55 db pad with an input and output impedance of 150 ohms. An "H" pad requires resistances of 0.534 ohms and 149 ohms. An "O" pad requires resistances of 151 ohms and 21.1 k ohms. Most studios stock resistors close to 151 ohms and 21.1 k ohms, but few parts boxes yield anything down around 0.534 ohms. Thus, at higher attenuations, the "O" pad and the unbalanced "Pi" pad use more common resistor values than corresponding "T" and "H" pads.

MEASURING ATTENUATION

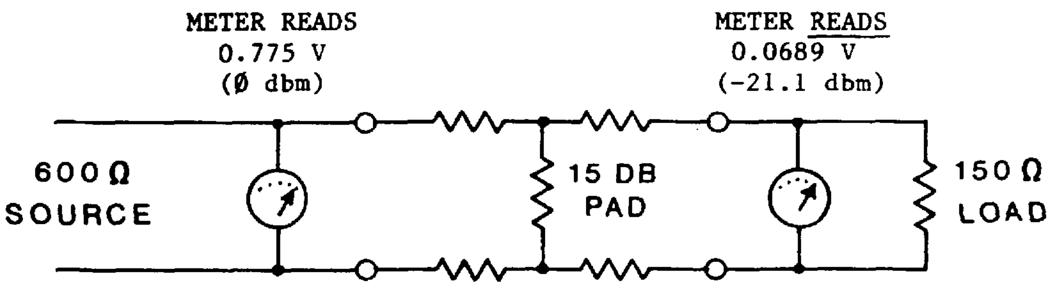
The db meter scale on nearly all AC VTVM's, distortion meters, VOM's, and similar instruments is calibrated to the 1 mW, 600 ohm standard for Ø dbm. When measuring signal levels in circuits with an impedance other than 600 ohms the meter calibration will no longer be valid.

Fortunately, when measuring a signal in a non-600 ohm circuit the basic db scale on the meter can be corrected by simply changing the Ø dbm reference level. For example, when measuring signal levels in a 150 ohm circuit just add 6.0 db to the meter reading to obtain the signal level in dbm. A meter reading of -20 db would then indicate a signal level of -14 dbm. A meter reading of -5 db would indicate a signal level of +1 dbm.

The correction factor for some other common audio impedances are: 500 ohms, add 0.8 db; 300 ohms, add 3.0 db; 150 ohms, add 6.0 db; 50 ohms, add 10.8 db; 37.5 ohms, add 12.0 db; 16 ohms, add 15.7 db; 8 ohms, add 18.8 db; 4 ohms, add 21.8 db.

This correction factor must be considered when measuring the attenuation of a resistive pad. The measurement is quite straightforward if the input and output impedances of the pad are identical. First, match the source and load impedances to those of the pad. Second, apply and measure an input signal using any convenient reference level. Finally, measure the signal across the load resistor. The attenuation of the pad is simply the input level (in db) minus the output level (in db). Meter correcting for non-600 ohm impedances is not necessary. The correcting factor cancels itself out mathematically.

If the input and output impedances are not identical, the two signal levels must first be converted to standard "600 ohm dbm". For example, assume a properly terminated 15 db pad with a 600 ohm input and a 150 ohm output impedance. With Ø dbm applied to the 600 ohm input, a meter connected across the 150 ohm output reads -21 db. This reading consists of the 15 db loss of the pad and an apparent additional 6.0 db loss due to the 600/150 ohm impedance change. The actual attenuation of the pad is 15 db even though the meter apparently indicates a 21 db loss.



$$P_{in} = \frac{E^2}{R} = \frac{(.775)^2}{600} = 1.0 \text{ mW} \qquad P_{out} = \frac{E^2}{R} = \frac{(.0689)^2}{150} = .0316 \text{ mW}$$

$$\text{db loss} = 10 \log \frac{1.0 \text{ mW}}{.0316 \text{ mW}} = 15 \text{ db actual pad loss}$$

VU METER PADS

VU meters are essentially AC voltmeters. They require an additional series resistance for proper calibration. In addition, the external circuit must provide a proper value of dampening resistance so the meter will have the correct ballistics for reading program levels. The basic VU meter circuit shown in figure 1 consists of the VU meter with an internal impedance of 3,900 ohms in series with a resistance of approximately 3,600 ohms. The 3,600 ohm resistance is normally a fixed resistor in series with a trim pot. The trim pot allows compensation for small differences in meter calibration.

By definition, a standard VU meter in series with the 3,600 ohm resistance will read Ø VU when connected across a 600 ohm circuit with a 1 khz sine wave at +4 dbm.

Don't confuse Ø VU with Ø dbm. Ø dbm is a very specific level (1 mW across 600 ohms) while Ø VU can be any reference level that the circuit demands. For example, Ø VU can be +4 dbm, +5 dbm, or +20 dbm. The db markings on the VU meter show the signal level with reference to the selected value of Ø VU. Thus, if the VU meter circuit is calibrated so that Ø VU = +6 dbm, then -2 VU would represent +4 dbm.

When the range of the VU meter must be extended so that Ø VU represents a level higher than +4 dbm, insert a 3,900/3,900 ohm "T" pad between the meter and the 3,600 ohm series resistance as shown in figure 2. The "T" pad drops the signal level to the meter while maintaining the proper shunt dampening so the meter reads properly on program material. In a practical circuit, of course, the input resistor of the "T" pad will be combined with the 3,600 ohm series resistance to save parts. The 1 k ohm trim pot should not be replaced with a larger value, lest someone be tempted to extend the range of the meter circuit by simply adding large amounts of series resistance.

The VU meter circuit and pad chart, figure 3, shows the values of resistors for VU meter pads for Ø VU = +5 dbm up through Ø VU = +34 dbm. The value shown for R_2 includes the 3 k ohm fixed resistor used in figures 1 & 2. The three resistors and trim pot are commonly mounted on a little circuit board and attatched to the terminal bolts of the meter.

One word of caution concerning VU meter calibration. Many inexpensive VU meters are nothing more than a cheap AC voltmeter with a different scale glued on. They often do not have the proper Ø VU = +4 dbm sensitivity and rarely show proper VU meter ballistics. This also applies to meters in consumer-type audio gear. Carefully check out the meter before use.

FIGURE 1

basic VU meter circuit

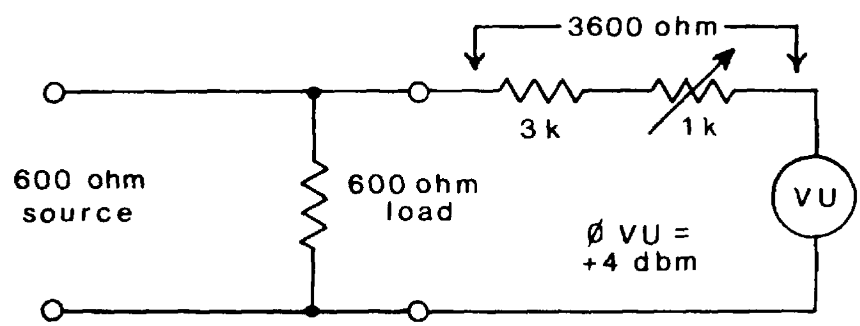


FIGURE 2

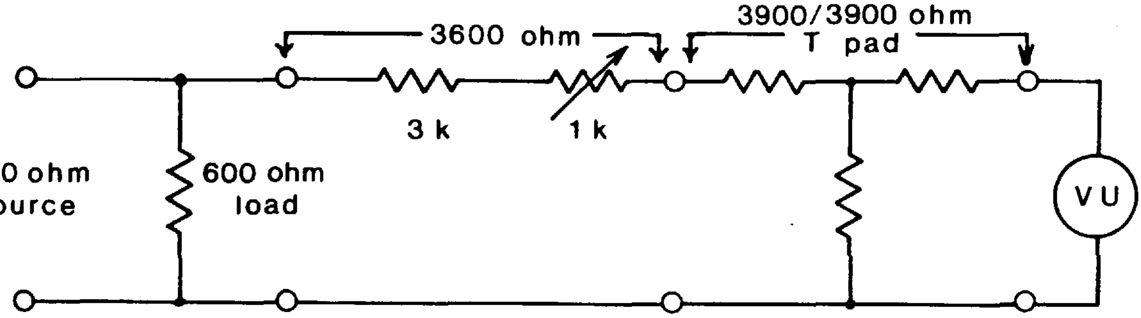
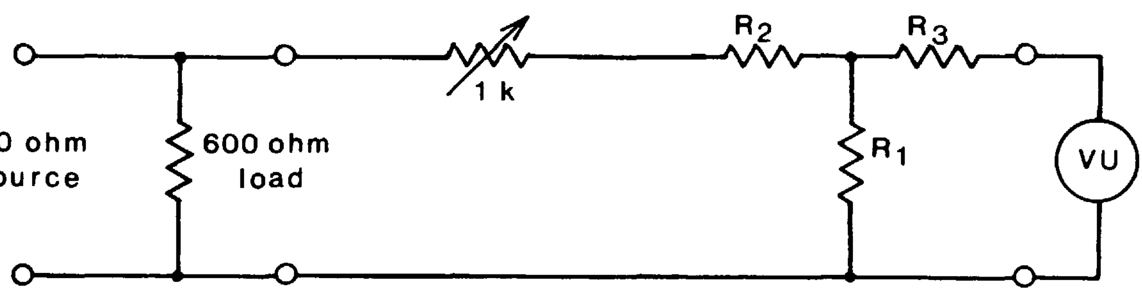


FIGURE 3 - VU METER PAD CHART

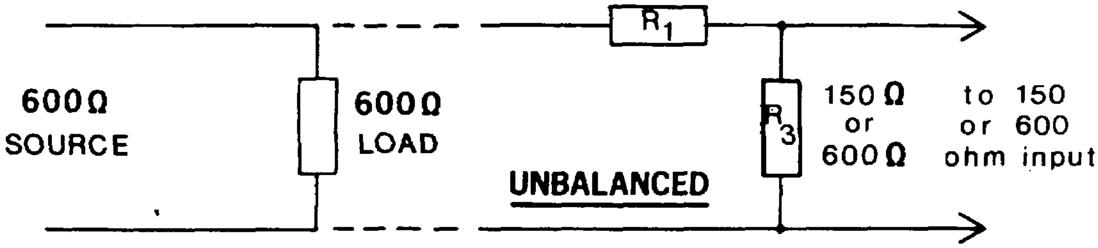


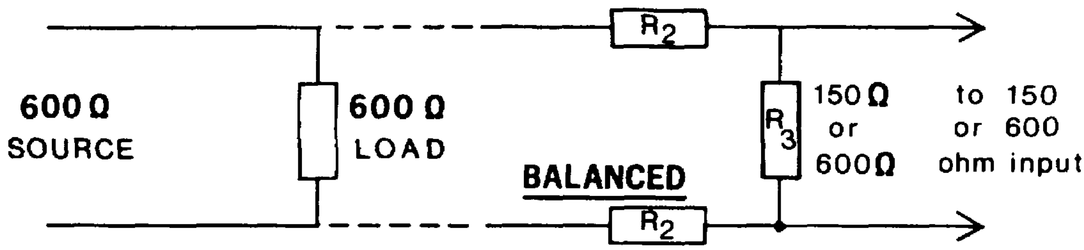
Ø VU EQUALS	R_1 OHMS	R_2 OHMS	R_3 OHMS	Ø VU EQUALS	R_1 OHMS	R_2 OHMS	R_3 OHMS
+ 5 dbm	33.8 k	3.22 k	224	+20 dbm	1.27 k	5.83 k	2.83 k
+ 6	16.8 k	3.45 k	447	+21	1.12 k	5.94 k	2.94 k
+ 7	11.1 k	3.67 k	667	+22	998	6.03 k	3.03 k
+ 8	8.18 k	3.88 k	882	+23	886	6.11 k	3.11 k
+ 9	6.42 k	4.09 k	1.09 k	+24	788	6.19 k	3.19 k
+10 dbm	5.22 k	4.30 k	1.30 k	+25 dbm	701	6.26 k	3.26 k
+11	4.35 k	4.49 k	1.49 k	+26	624	6.33 k	3.33 k
+12	3.69 k	4.70 k	1.68 k	+27	555	6.38 k	3.38 k
+13	3.17 k	4.86 k	1.86 k	+28	494	6.44 k	3.44 k
+14	2.74 k	5.03 k	2.03 k	+29	440	6.49 k	3.49 k
+15 dbm	2.39 k	5.19 k	2.19 k	+30 dbm	392	6.53 k	3.53 k
+16	2.09 k	5.33 k	2.33 k	+31	349	6.57 k	3.57 k
+17	1.84 k	5.47 k	2.47 k	+32	311	6.60 k	3.60 k
+18	1.62 k	5.60 k	2.60 k	+33	277	6.63 k	3.63 k
+19	1.43 k	5.72 k	2.72 k	+34	247	6.66 k	3.66 k

BRIDGING PADS

Bridging pads are used to "steal" a signal from a circuit which is already loaded or terminated without further loading down that circuit.

A bridging pad consists of a series "bridging" resistance (R_1 or R_2) and a terminating resistor (R_3) across the input of the device being fed by the pad.





Bridging pads are normally specified by the approximate value of additional loading that they put on the 600 ohm load of the terminated circuit

The chart below shows the loss for common values of bridging pads which bridge off a 600 ohm terminated circuit into either a 600 ohm or 150 ohm device.

Bridging impedance	R_1 Ohms	R_2 Ohms	Loss in DB for: 600 ohm Input	Loss in DB for: 150 ohm Input
5 k ohms	5 k	2.5k	24.9	30.6
10 k ohms	10 k	5 k	30.7	36.5
15 k ohms	15 k	7.5k	34.2	40.0
20 k ohms	20 k	10 k	36.6	42.5
25 k ohms	25 k	12.5k	38.5	44.5
30 k ohms	30 k	15 k	40.1	46.0

LATTICE SPLITTING PAD

Technical publications rarely mention this unique little circuit. The lattice splitting pad finds many uses in the audio studio. It may be used to combine two audio sources into a single audio output or to derive two separate outputs from a single audio source. The lattice splitting pad is unique because the two inputs (or two outputs) are totally isolated from one another.

Figure 1 shows the pad being used to combine two audio sources into a single output. A typical use would be to connect two tape cart machines to a single console input. The pad has a 6 db loss from either input to the pad output. Changing the impedance of either input does not affect this 6 db loss. In fact, a +4 dbm cart machine output produces a -2 dbm signal at the pad output even if the other cart output line opens or shorts!

Figure 2 shows the pad turned around to provide two separate, isolated outputs from a single audio source. Again, the pad has a 6 db loss from its input to either output. If the audio source provides +8 dbm, +2 dbm will appear at each isolated output even if the other output opens or shorts! In addition, a signal accidentally applied to one of the isolated outputs will not appear at the other isolated output.

This pad may be used with any impedance circuit. Simply make each of the three pad resistors equal to the impedance of the single input or output. The 6 db loss holds true regardless of impedance.

FIGURE 1

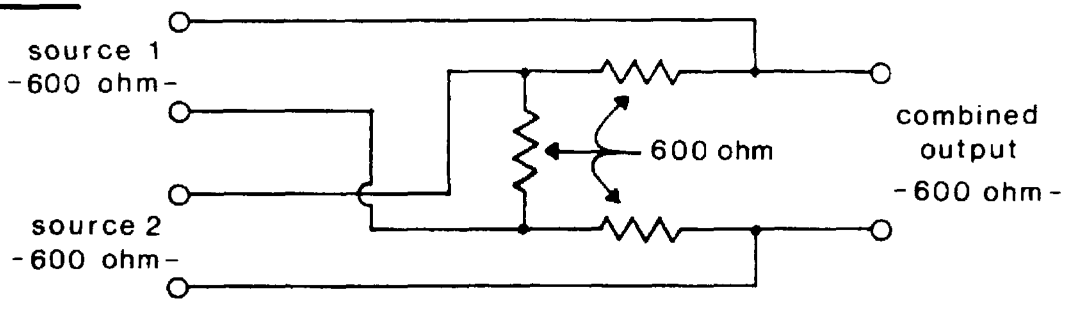
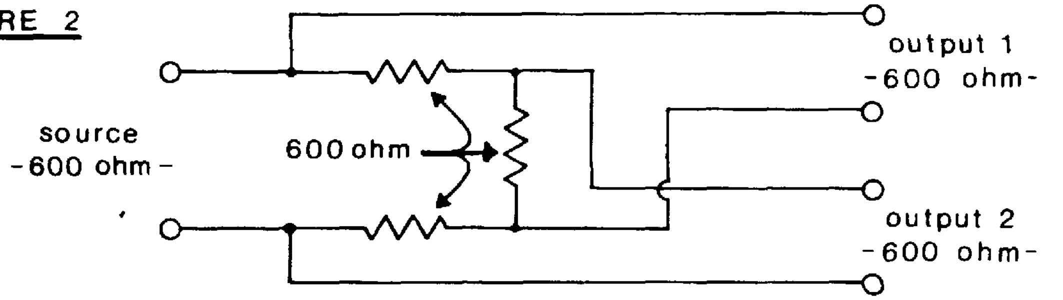
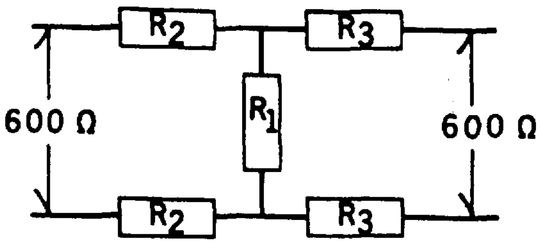
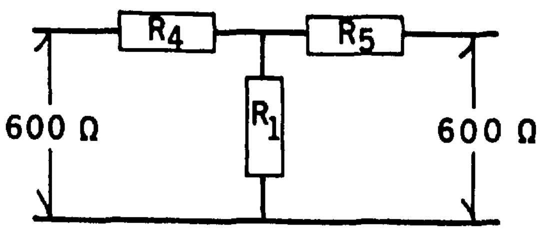


FIGURE 2





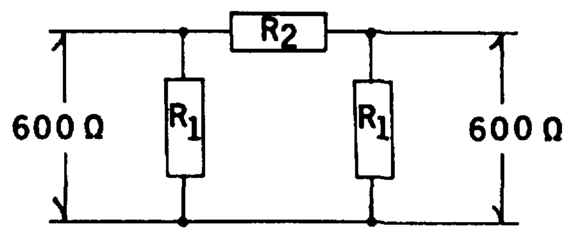


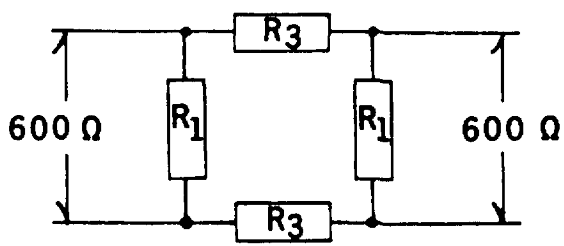
600 OHM
T & H PADS

 AR-08

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
1	5.20 k	17.3	17.3	34.5	34.5
2	2.58 k	34.4	34.4	68.8	68.8
3	1.70 k	51.3	51.3	103	103
4	1.26 k	67.9	67.9	136	136
5	987	84.0	84.0	168	168
6	803	99.7	99.7	199	199
7	670	115	115	229	229
8	568	129	129	258	258
9	487	143	143	286	286
10	422	156	156	312	312
11	367	168	168	336	336
12	322	180	180	359	359
13	283	190	190	380	380
14	249	200	200	400	400
15	220	209	209	419	419
16	195	218	218	436	436
17	173	226	226	451	451
18	154	233	233	466	466
19	136	239	239	479	479
20	121	245	245	491	491
21	108	251	251	502	502
22	95.9	256	256	512	512
23	85.4	260	260	521	521
24	76.0	264	264	529	529
25	67.7	268	268	536	536
26	60.3	271	271	543	543
27	53.7	274	274	549	549
28	47.9	277	277	554	554
29	42.6	279	279	559	559
30	38.0	282	282	563	563

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
31	33.9	284	284	567	567
32	30.2	285	285	571	571
33	26.9	287	287	574	574
34	24.0	288	288	577	577
35	21.4	290	290	579	579
36	19.0	291	291	581	581
37	17.0	292	292	583	583
38	15.1	293	293	585	585
39	13.5	293	293	587	587
40	12.0	294	294	588	588
41	10.7	295	295	589	589
42	9.53	295	295	591	591
43	8.50	296	296	592	592
44	7.57	296	296	592	592
45	6.75	297	297	593	593
46	6.01	297	297	594	594
47	5.36	297	297	595	595
48	4.78	298	298	595	595
49	4.26	298	298	596	596
50	3.79	298	298	596	596
51	3.38	298	298	597	597
52	3.01	299	299	597	597
53	2.69	299	299	597	597
54	2.39	299	299	598	598
55	2.13	299	299	598	598
56	1.90	299	299	598	598
57	1.70	299	299	598	598
58	1.51	299	299	598	598
59	1.35	299	299	599	599
60	1.20	299	299	599	599





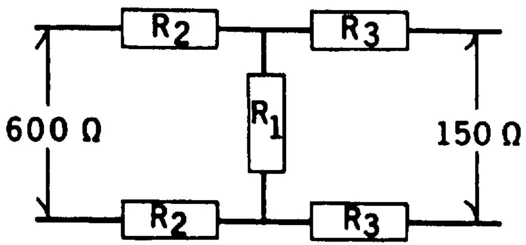
600 OHM

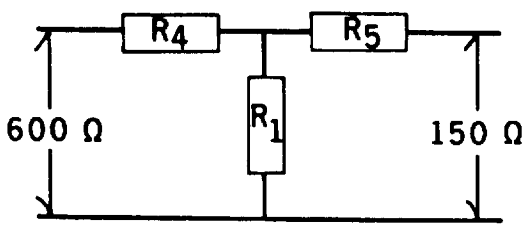
Pi & O PADS

 AR-09

DB ATTEN.	R_1 OHMS	R_2 OHMS	R_3 OHMS
1	10.4 k	69.2	34.6
2	5.23 k	139	69.7
3	3.51 k	211	106
4	2.65 k	286	143
5	2.14 k	365	182
6	1.81 k	448	224
7	1.57 k	538	269
8	1.39 k	634	317
9	1.26 k	739	370
10	1.15 k	854	427
11	1.07 k	980	490
12	1.00 k	1.12 k	559
13	946	1.27 k	636
14	899	1.44 k	722
15	860	1.63 k	817
16	826	1.85 k	923
17	797	2.08 k	1.04 k
18	773	2.35 k	1.17 k
19	752	2.64 k	1.32 k
20	733	2.97 k	1.49 k
21	717	3.34 k	1.67 k
22	704	3.75 k	1.88 k
23	691	4.22 k	2.11 k
24	681	4.74 k	2.37 k
25	672	5.32 k	2.66 k
26	663	5.97 k	2.99 k
27	656	6.70 k	3.35 k
28	650	7.52 k	3.76 k
29	644	8.45 k	4.22 k
30	639	9.48 k	4.74 k

DB ATTEN.	R_1 OHMS	R_2 OHMS	R_3 OHMS
31	635	10.6 k	5.32 k
32	631	11.9 k	5.97 k
33	627	13.4 k	6.70 k
34	624	15.0 k	7.52 k
35	622	16.9 k	8.43 k
36	619	18.9 k	9.46 k
37	617	21.2 k	10.6 k
38	615	23.8 k	11.9 k
39	614	26.7 k	13.4 k
40	612	30.0 k	15.0 k
41	611	33.7 k	16.8 k
42	610	37.8 k	18.9 k
43	609	42.4 k	21.2 k
44	608	47.5 k	23.8 k
45	607	53.3 k	26.7 k
46	606	59.9 k	29.9 k
47	605	67.2 k	33.6 k
48	605	75.4 k	37.7 k
49	604	84.6 k	42.3 k
50	604	94.9 k	47.4 k
51	603	106 k	53.2 k
52	603	119 k	59.7 k
53	603	134 k	67.0 k
54	602	150 k	75.2 k
55	602	169 k	84.4 k
56	602	189 k	94.6 k
57	602	212 k	106 k
58	602	238 k	119 k
59	601	267 k	134 k
60	601	300 k	150 k



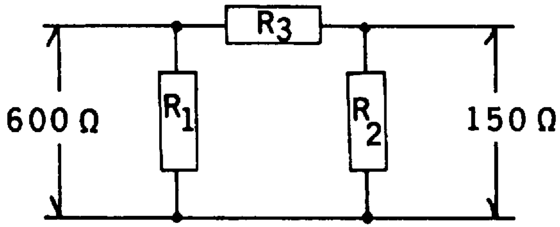


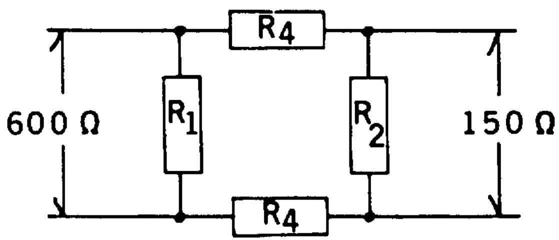
600/150 OHM T & H PADS

 AR-10

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
Minimum loss for this impedance ratio is 11.4 DB					
11.4	173	260	0	520	0
12	161	260	4.67	520	9.34
13	141	261	12.2	522	24.4
14	125	263	18.9	525	37.8
15	110	265	24.8	529	49.6
16	97.5	267	30.1	533	60.2
17	86.5	269	34.8	538	69.6
18	76.8	271	39.0	543	78.1
19	68.2	274	42.8	547	85.7
20	60.6	276	46.2	552	92.4
21	53.9	278	49.3	556	98.5
22	48.0	280	52.0	560	104
23	42.7	282	54.4	563	109
24	38.0	283	56.6	567	113
25	33.9	285	58.6	570	117
26	30.2	286	60.3	573	121
27	26.9	288	61.9	576	124
28	23.9	289	63.3	578	127
29	21.3	290	64.5	580	129
30	19.0	291	65.7	582	131

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
31	16.9	292	66.7	584	133
32	15.1	293	67.6	586	135
33	13.4	294	68.4	587	137
34	12.0	294	69.1	589	138
35	10.7	295	69.7	590	139
36	9.51	295	70.3	591	141
37	8.48	296	70.8	592	142
38	7.55	296	71.3	593	142
39	6.73	297	71.7	593	143
40	6.00	297	72.0	594	144
41	5.35	297	72.3	595	145
42	4.77	298	72.6	595	145
43	4.25	298	72.9	596	146
44	3.79	298	73.1	596	146
45	3.37	298	73.3	597	147
46	3.01	299	73.5	597	147
47	2.68	299	73.7	597	147
48	2.39	299	73.8	598	148
49	2.13	299	73.9	598	148
50	1.90	299	74.1	598	148
51	1.69	299	74.2	598	148
52	1.51	299	74.3	599	148
53	1.34	299	74.3	599	149
54	1.20	299	74.4	599	149
55	1.07	299	74.5	599	149
56	.951	300	74.5	599	149
57	.848	300	74.6	599	149
58	.755	300	74.6	599	149
59	.673	300	74.7	599	149
60	.600	300	74.7	599	149



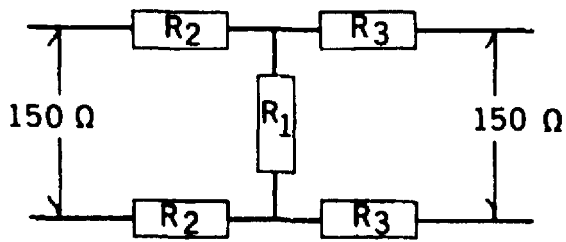


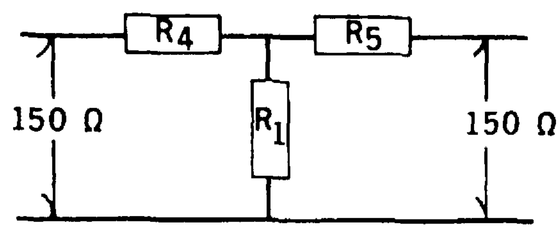
600/150 OHM
Pi & O PADS

 AR-11

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS
MINIMUM LOSS FOR THIS IMPEDANCE RATIO IS 11.4 DB				
11.4	(open)	173	520	260
12	9.64 k	173	559	280
13	3.69 k	172	636	318
14	2.38 k	171	722	361
15	1.81 k	170	817	408
16	1.50 k	169	923	461
17	1.29 k	167	1.04 k	520
18	1.15 k	166	1.17 k	586
19	1.05 k	164	1.32 k	660
20	974	163	1.49 k	743
21	914	162	1.67 k	835
22	866	161	1.88 k	938
23	827	160	2.11 k	1.05 k
24	795	159	2.37 k	1.18 k
25	769	158	2.66 k	1.33 k
26	746	157	2.99 k	1.49 k
27	727	156	3.35 k	1.68 k
28	711	156	3.76 k	1.88 k
29	697	155	4.22 k	2.11 k
30	685	155	4.74 k	2.37 k

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS
31	675	154	5.32 k	2.66 k
32	666	154	5.97 k	2.98 k
33	658	153	6.70 k	3.35 k
34	651	153	7.52 k	3.76 k
35	646	153	8.43 k	4.22 k
36	640	152	9.46 k	4.73 k
37	636	152	10.6 k	5.31 k
38	632	152	11.9 k	5.96 k
39	628	152	13.4 k	6.68 k
40	625	151	15.0 k	7.50 k
41	622	151	16.8 k	8.41 k
42	620	151	18.9 k	9.44 k
43	617	151	21.2 k	10.6 k
44	615	151	23.8 k	11.9 k
45	614	151	26.7 k	13.3 k
46	612	151	29.9 k	15.0 k
47	611	151	33.6 k	16.8 k
48	610	151	37.7 k	18.8 k
49	609	151	42.3 k	21.1 k
50	608	150	47.4 k	23.7 k
51	607	150	53.2 k	26.6 k
52	606	150	59.7 k	29.9 k
53	605	150	67.0 k	33.5 k
54	605	150	75.2 k	37.6 k
55	604	150	84.4 k	42.2 k
56	604	150	94.6 k	47.3 k
57	603	150	106 k	53.1 k
58	603	150	119 k	59.6 k
59	603	150	134 k	66.8 k
60	602	150	150 k	75.0 k



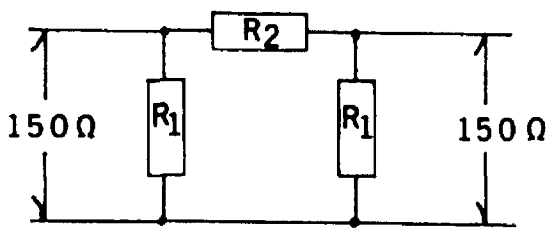


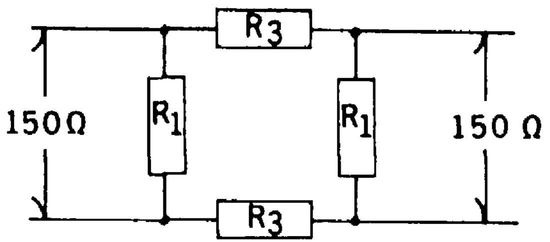
150 OHM T & H PADS

 AR-12

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
1	1.30 k	4.31	4.31	8.63	8.63
2	646	8.60	8.60	17.2	17.2
3	426	12.8	12.8	25.6	25.6
4	314	17.0	17.0	33.9	33.9
5	247	21.0	21.0	42.0	42.0
6	201	24.9	24.9	49.8	49.8
7	167	28.7	28.7	57.4	57.4
8	142	32.3	32.3	64.6	64.6
9	122	35.7	35.7	71.4	71.4
10	105	39.0	39.0	77.9	77.9
11	91.8	42.0	42.0	84.0	84.0
12	80.4	44.9	44.9	89.8	89.8
13	70.7	47.6	47.6	95.1	95.1
14	62.3	50.0	50.0	100	100
15	55.1	52.4	52.4	105	105
16	48.8	54.5	54.5	109	109
17	43.2	56.4	56.4	113	113
18	38.4	58.2	58.2	116	116
19	34.1	59.9	59.9	120	120
20	30.3	61.4	61.4	123	123
21	27.0	62.7	62.7	125	125
22	24.0	64.0	64.0	128	128
23	21.3	65.1	65.1	130	130
24	19.0	66.1	66.1	132	132
25	16.9	67.0	67.0	134	134
26	15.1	67.8	67.8	136	136
27	13.4	68.6	68.6	137	137
28	12.0	69.3	69.3	139	139
29	10.7	69.9	69.9	140	140
30	9.50	70.4	70.4	141	141

DB ATTEN	R_1 OHMS	R_2 OHMS	R_3 OHMS	R_4 OHMS	R_5 OHMS
31	8.46	70.9	70.9	142	142
32	7.54	71.3	71.3	143	143
33	6.72	71.7	71.7	143	143
34	5.99	72.1	72.1	144	144
35	5.34	72.4	72.4	145	145
36	4.76	72.7	72.7	145	145
37	4.24	72.9	72.9	146	146
38	3.78	73.1	73.1	146	146
39	3.37	73.3	73.3	147	147
40	3.00	73.5	73.5	147	147
41	2.67	73.7	73.7	147	147
42	2.38	73.8	73.8	148	148
43	2.12	73.9	73.9	148	148
44	1.89	74.1	74.1	148	148
45	1.69	74.2	74.2	148	148
46	1.50	74.3	74.3	149	149
47	1.34	74.3	74.3	149	149
48	1.19	74.4	74.4	149	149
49	1.06	74.5	74.5	149	149
50	0.949	74.5	74.5	149	149
51	0.846	74.6	74.6	149	149
52	0.754	74.6	74.6	149	149
53	0.672	74.7	74.7	149	149
54	0.599	74.7	74.7	149	149
55	0.534	74.7	74.7	149	149
56	0.476	74.8	74.8	150	150
57	0.424	74.8	74.8	150	150
58	0.378	74.8	74.8	150	150
59	0.337	74.8	74.8	150	150
60	0.300	74.9	74.9	150	150





150 OHM
Pi & O PADS

 AR-13

DB ATTEN.	R_1 OHMS	R_2 OHMS	R_3 OHMS	DB ATTEN.	R_1 OHMS	R_2 OHMS	R_3 OHMS
1	2.61 k	17.3	8.65	31	159	2.66 k	1.33 k
2	1.31 k	34.8	17.4	32	158	2.98 k	1.49 k
3	877	52.8	26.4	33	157	3.35 k	1.67 k
4	663	71.6	35.8	34	156	3.76 k	1.88 k
5	535	91.2	45.6	35	155	4.22 k	2.11 k
6	451	112	56.0	36	155	4.73 k	2.37 k
7	392	134	67.2	37	154	5.31 k	2.65 k
8	348	159	79.3	38	154	5.96 k	2.98 k
9	315	185	92.4	39	153	6.68 k	3.34 k
10	289	213	107	40	153	7.50 k	3.75 k
11	268	245	122	41	153	8.41 k	4.21 k
12	251	280	140	42	152	9.44 k	4.72 k
13	237	318	159	43	152	10.6 k	5.30 k
14	225	361	180	44	152	11.9 k	5.94 k
15	215	408	204	45	152	13.3 k	6.67 k
16	207	461	231	46	152	15.0 k	7.48 k
17	199	520	260	47	151	16.8 k	8.40 k
18	193	586	293	48	151	18.8 k	9.42 k
19	188	660	330	49	151	21.1 k	10.6 k
20	183	743	371	50	151	23.7 k	11.9 k
21	179	835	417	51	151	26.6 k	13.3 k
22	176	938	469	52	151	29.9 k	14.9 k
23	173	1.05 k	527	53	151	33.5 k	16.8 k
24	170	1.18 k	592	54	151	37.6 k	18.8 k
25	168	1.33 k	665	55	151	42.2 k	21.1 k
26	166	1.49 k	746	56	150	47.3 k	23.7 k
27	164	1.68 k	838	57	150	53.1 k	26.5 k
28	162	1.88 k	940	58	150	59.6 k	29.8 k
29	161	2.11 k	1.06 k	59	150	66.8 k	33.4 k
30	160	2.37 k	1.18 k	60	150	75.0 k	37.5 k

STANDARD RESISTOR VALUES

Not many years ago the standard resistor for audio pads was the 10%, 1/2 Watt, carbon composition type. Recent technology has made 5%, 1/4 Watt carbon composition and carbon film resistors widely available at a very low cost. The 5%, 1/4 Watt is the best choice for nearly all audio applications. The 1/4 Watt size matches compact, solid-state equipment. The 5% tolerance gives a wide selection of standard resistor values in addition to the 5% accuracy.

Carbon film resistors offer a slightly better noise figure than the composition type. Critical instrumentation applications generally use metal film resistors because of their far superior noise figures and inherent stability. Wire-wound resistors have the lowest noise figure, being only slightly better than metal film types. The once-common, non-inductive, wire-wound resistor has nearly disappeared in favor of the much less expensive metal film type.

 AR-14

E.I.A. 5% & 10% RESISTOR VALUES

Ohms	Ohms	Ohms	Ohms	Ohms	Ohms	Ohms
*1.0	11	*120	1.3 k	*15 k	160 k	*1.8 Meg
1.1	*12	130	*1.5 k	16 k	*180 k	2.0
*1.2	13	*150	1.6 k	*18 k	200 k	*2.2
1.3	*15	160	*1.8 k	20 k	*220 k	2.4
*1.5	16	*180	2.0 k	*22 k	240 k	*2.7 Meg
1.6	*18	200	*2.2 k	24 k	*270 k	3.0 Meg
*1.8	20	*220	2.4 k	*27 k	300 k	*3.3
2.0	*22	240	*2.7 k	30 k	*330 k	3.6
*2.2	24	*270	3.0 k	*33 k	360 k	*3.9
2.4	*27	300	*3.3 k	36 k	*390 k	4.3 Meg
*2.7	30	*330	3.6 k	*39 k	430 k	*4.7 Meg
3.0	*33	360	*3.9 k	43 k	*470 k	5.1
*3.3	36	*390	4.3 k	*47 k	510 k	*5.6
3.6	*39	430	*4.7 k	51 k	*560 k	6.2
*3.9	43	*470	5.1 k	*56 k	620 k	*6.8 Meg
4.3	*47	510	*5.6 k	62 k	*680 k	7.5 Meg
*4.7	51	*560	6.2 k	*68 k	750 k	*8.2
5.1	*56	620	*6.8 k	75 k	*820 k	9.1
*5.6	62	*680	7.5 k	*82 k	910 k	*10
6.2	*68	750	*8.2 k	91 k	*1.0 Meg	11 Meg
*6.8	75	*820	9.1 k	*100 k	1.1 Meg	*12 Meg
7.5	*82	910	*10 k	110 k	*1.2	13
*8.2	91	*1.0 k	11 k	*120 k	1.3	*15
9.1	*100	1.1 k	*12 k	130 k	*1.5	16
* 10	110	*1.2 k	13 k	*150 k	1.6 Meg	*18 Meg

ALL VALUES AVAILABLE IN 5% TOLERANCE
10% TOLERANCE AVAILABLE ONLY IN (*) VALUES