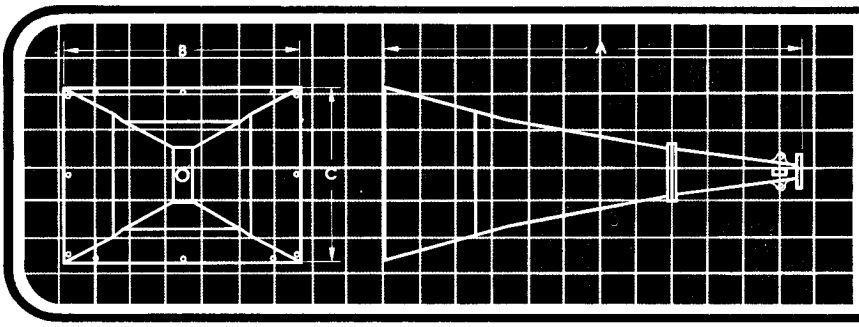
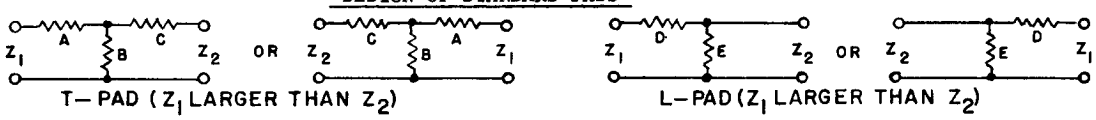


ALTEC ENGINEERING NOTES

Technical Letter No. 133

DESIGN OF STANDARD PADS



T– PAD (Z_1 LARGER THAN Z_2) L–PAD (Z_1 LARGER THAN Z_2)

	VALUES OF PAD ARMS - OHMS												Constants for Formula		Max. Ratio
	1000:1000			1000:500			1000:250			1000:100					
Loss	A	B	C	A	B	C	A	B	C	A	B	C	M	N	Z_1/Z_2
1db	50	8640	50										8.69	8.64	1.01
2	100	4340	100										4.44	4.34	1.05
3	170	2830	170				IMPOSSIBLE						3.00	2.83	1.12
4	220	2110	220										2.33	2.11	1.23
5	280	1650	280				COMBINATIONS						1.93	1.65	1.37
6	340	1330	340										1.67	1.33	1.56
7	380	1220	380										1.50	1.12	1.8
8	430	950	430	710	670	20							1.38	.95	2.1
9	480	815	480	710	580	80							1.29	.815	2.5
10	520	700	520	720	500	110							1.22	.702	3.0
12	600	540	600	750	380	190	860	270	10				1.14	.54	4.4
14	660	416	660	790	290	250	870	210	60				1.08	.416	6.8
16	720	327	720	820	330	290	890	160	100	950	103	0	1.05	.327	10.4
18	780	256	780	850	180	330	900	130	120	950	80	20	1.03	.256	16.7
20	820	202	820	880	140	370	920	100	150	950	64	36	1.02	.202	25.4
25	900	113	900	920	80	420	950	60	190	960	36	64	1.01	.113	79.8
30	940	63	940	955	45	455	970	30	220	980	20	80	1.00	.063	247.
40	980	20	980	986	14	486	990	10	240	990	6	94	1.00	.02	2400

NOTES:

1. In all cases Z_1 is larger than Z_2. For 500:1000, input is Z_2= 500, output is Z_1=1000 and column headed 1000:500 applies.

2. For Z_1 other than 1000 ohms, multiply A, B and C by $Z_1/1000$. (Examples: For 5000 ohms, multiply by 5., for 600 ohms multiply by .6)

3. To compute any possible pad use following formulae in which M and N are read from the table opposite the required loss:

   $A = Z_1\left(M - N\sqrt{Z_2/Z_1}\right)$ $B = Z_1 N\sqrt{Z_2/Z_1}$ $C = Z_1\left(M\, Z_2/Z_1 - N\sqrt{Z_2/Z_1}\right)$

   For loss values not given in the table, M and N may be computed as follows:

   $M = (K^2+1) \div (K^2-1)$ $N = 2K \div (K^2-1)$

   In these formulae K is the <u>voltage</u> ratio (larger than unity) corresponding to the loss in db. K may be read from the chart DB vs. Voltage Ratio.

4. Certain combinations of loss and impedance ratio cannot be obtained. The minimum value of loss is given by the 1st column when the impedance ratio is per column Z_1/Z_2.

<u>L PADS</u> are used to match two impedances with minimum loss. Leg D is in series with the <u>larger</u> circuit impedance, Z_1. E shunts the <u>smaller</u> circuit impedance, Z_2.

$D = Z_1\sqrt{1-Z_2/Z_1}$ $E = Z_2 \div \sqrt{1-Z_2/Z_1}$

The loss is read from the first column corresponding to Z_2/Z_1 in the last column.

Example: Match a 150 ohm source to a 600 load. $Z = 600$, $Z_2 = 150$. $\sqrt{1-Z_2/Z_1} = .87$.
$D = 600 \times .87 = 520$ ohms; $E = 150 \div .87 = 173$ ohms. E shunts the 150 ohm circuit.

VOLTAGES FOR VARIOUS POWER LEVELS

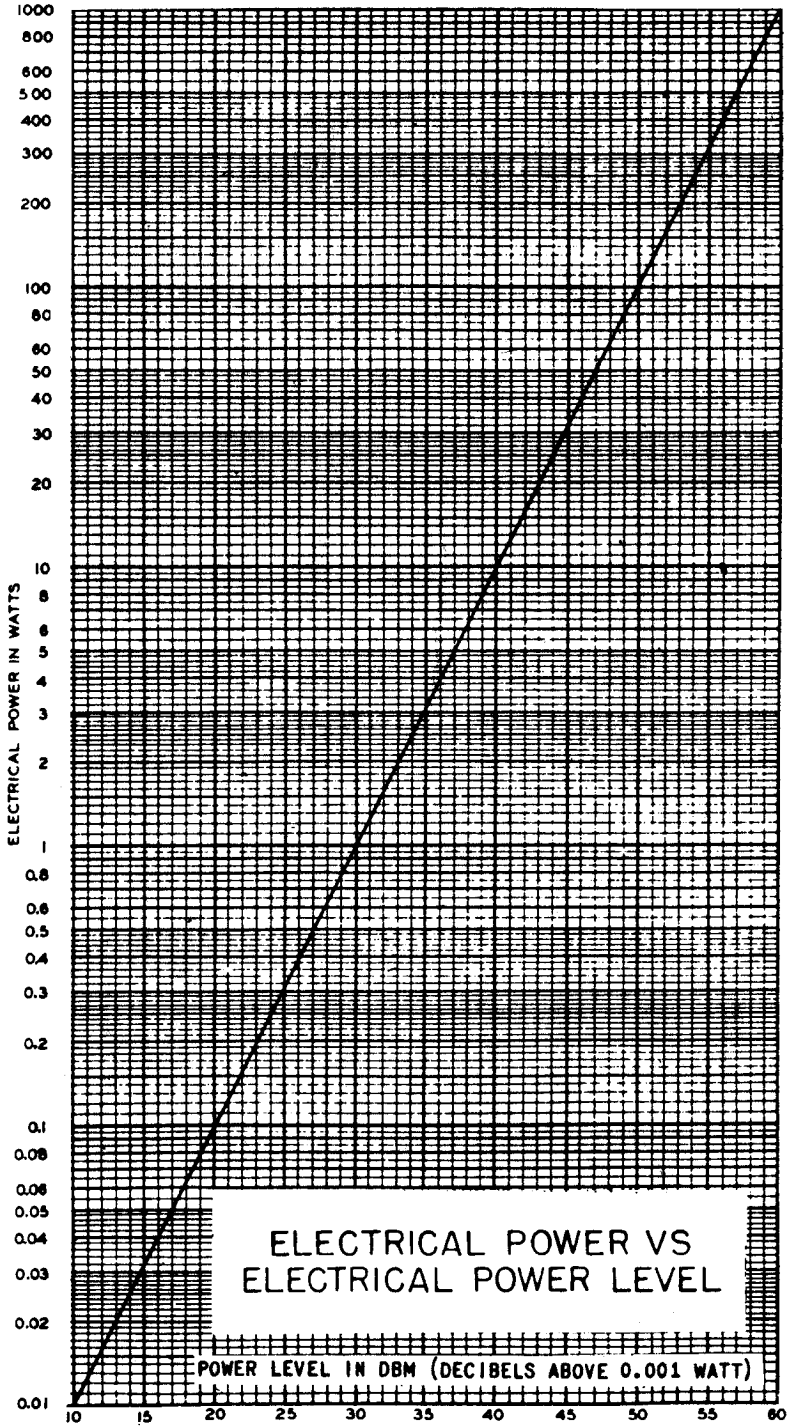
NOTE: For dbm of higher values, subtract 20, 40, or 60 db and refer to table below for result, then select appropriate decimal. Examples:

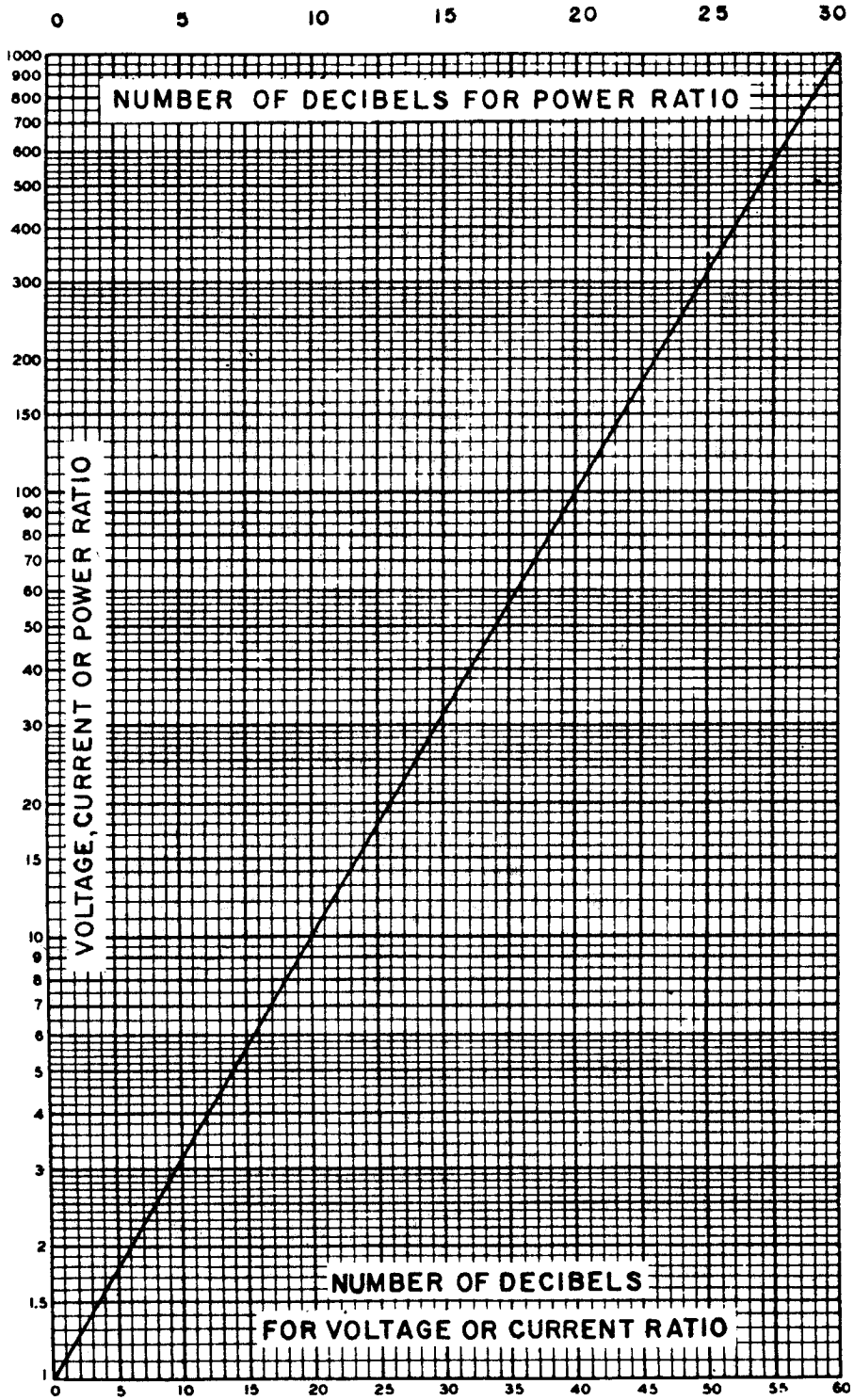
+22 dbm: (subtract 20) +2 dbm = 1.26v (1000 ohms),+22 = 12.6v (1000 ohms)
+32 dbm: (subtract 20)+12 dbm = 3.98v (1000 ohms),+32 = 39.8v (1000 ohms)
+42 dbm: (subtract 40) +2 dbm = 1.26v (1000 ohms),+42 = 126v (1000 ohms)
+52 dbm: (subtract 40)+12 dbm = 3.96v (1000 ohms),+52 = 398v (1000 ohms)

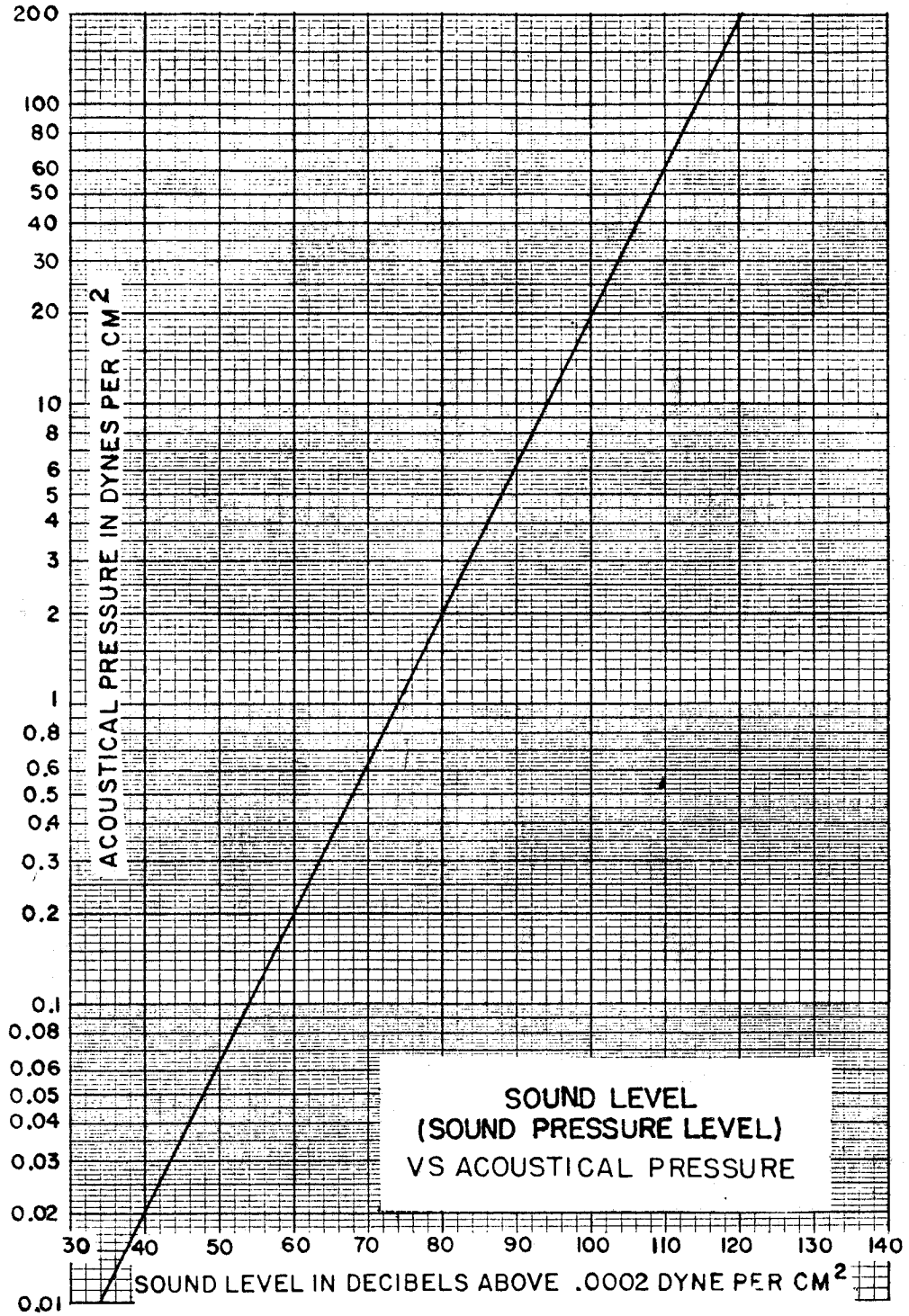
For dbm of lower values, reduce number by 20, 40, or 60 and refer to table below; then select proper decimal. Examples:

-22 dbm (reduce by 20) -2 dbm =.79v (1000 ohms), -22 = .079v (1000 ohms)
-32 dbm (reduce by 20)-12 dbm =.25v (1000 ohms), -32 = .025v (1000 ohms)
-42 dbm (reduce by 40) -2 dbm =.79v (1000 ohms), -42 = .0079v (1000 ohms)
-52 dbm (reduce by 40)-12 dbm =.25v (1000 ohms), -52 = .0025v (1000 ohms)

dbm	VOLTAGE (at listed impedance)									
	4	8	16	150	500	600	1000	5000	15,000	50,000
-20	.006	.009	.013	.039	.071	.078	.100	.224	.388	..707
-18	.008	.011	.016	.048	.089	.098	.126	.282	.488	.891
-16	.010	.014	.020	.061	.112	.122	.158	.354	.613	1.12
-14	.013	.018	.025	.077	.141	.154	.199	.446	.772	1.41
-12	.016	.022	.032	.097	.177	.195	.251	.562	.974	1.71
-10	.020	.028	.040	.122	.223	.245	.316	.708	1.22	2.23
- 8	.025	.035	.051	.154	.281	.308	.398	.892	1.54	2.81
- 6	.032	.045	.064	.193	.354	.388	.501	1.12	1.94	3.54
- 4	.040	.056	.080	.244	.446	.489	.631	1.41	2.45	4.46
- 2	.050	.070	.101	.307	.561	.615	.794	1.78	3.08	5.61
0.0	.063	.089	.127	.387	.707	.775	1.000	2.24	3.88	7.07
+ 2	.079	.112	.160	.480	.890	.977	1.26	2.82	4.88	8.91
+ 4	.099	.141	.201	.610	1.12	1.22	1.58	3.54	6.13	11.2
+ 6	.125	.177	.253	.770	1.41	1.54	1.99	4.46	7.72	14.1
+ 8	.158	.223	.319	.970	1.77	1.94	2.51	5.62	9.74	17.1
+10	.199	.281	.401	1.22	2.23	2.45	3.16	7.08	12.3	22.3
+12	.251	.354	.510	1.54	2.81	3.08	3.98	8.92	15.4	28.1
+14	.316	.446	.636	1.93	3.54	3.88	5.01	11.2	19.5	35.4
+16	.398	.562	.801	2.44	4.46	4.90	6.31	14.1	24.5	44.6
+18	.500	.707	1.01	3.07	5.61	6.15	7.94	17.8	30.8	56.1
+20	.630	.890	1.27	3.87	7.07	7.75	10.00	22.4	38.8	70.7
+22	.794	1.12	1.60	4.80	8.90	9.77	12.60	28.2	48.9	89.0
+24	.995	1.41	2.01	6.10	11.2	12.2	15.8	35.4	61.3	112
+26	1.25	1.77	2.50	7.70	14.1	15.4	19.9	44.6	77.2	141
+28	1.58	2.24	3.20	9.70	17.7	19.5	25.1	56.2	97.3	177
+30	1.99	2.81	4.01	12.2	22.3	24.5	31.6	70.8	122.6	223
+32	2.51	3.54	5.10	15.4	28.1	30.8	39.8	89.2	154.4	281
+34	3.16	4.46	6.36	19.3	35.4	38.8	50.1	112.2	194.3	354
+36	3.98	5.62	8.00	24.4	44.6	49.0	63.1	141.3	244.8	446
+38	5.00	7.07	10.10	30.7	56.1	61.5	79.4	177.9	308.0	561
+40	6.30	8.90	12.7	38.7	70.7	77.5	100.0	224.0	388	707
+42	7.94	11.2	16.0	48.0	80,9	97.7	126	282.2	488.8	890
+44	9.95	14.1	20.1	61.0	112	122	158	353.9	613	1117
+46	12.5	17.7	25.3	77.0	141	154	199	445.7	772.1	1406
+48	15.8	22.4	31.9	97.0	177	195	251	562.2	973.8	1775
+50	19.9	28.1	40.0	122	223	245	316	707.8	1226.1	2234


ELECTRICAL POWER IN WATTS
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
0.08
0.06
0.05
0.04
0.03
0.02
0.01
10 15 20 25 30 35 40 45 50 55 60
POWER LEVEL IN DBM (DECIBELS ABOVE 0.001 WATT)
ELECTRICAL POWER VS
ELECTRICAL POWER LEVEL


0 5 10 15 20 25 30
1000
900
800
700
600
500
400
300
200
150
100
90
80
70
60
50
40
30
20
15
10
9
8
7
6
5
4
3
2
1.5
1
NUMBER OF DECIBELS FOR POWER RATIO
VOLTAGE, CURRENT OR POWER RATIO
NUMBER OF DECIBELS
FOR VOLTAGE OR CURRENT RATIO
0 5 10 15 20 25 30 35 40 45 50 55 60



LENGTH OF CABLE FOR 3 db LOSS AT 10kc

	30 mmf/ft	60 mmf/ft
1: Source: 150 ohms, Load: Very High, Rp=150Ω. Example: Low-Z microphone to unterminated input XF*	3000 ft	1500 ft
2: Source: 600 ohms, Load: 600 ohms, Rp=300Ω. Example: 600 ohm attenuator to 436B with 600 ohm resistor across input.	1600 ft	800 ft
3: Source: 600 ohms, Load: Very high, Rp=600Ω. Example: As above with 600 ohm resistor omitted from 436B input.	800 ft	400 ft
4: Source: 20,000 ohms, Load: 20,000 ohms, Rp=10,000Ω.	50 ft	25 ft
5: Source: 20,000 ohms, Load: 100,000 ohms, Rp=18,000Ω. Example: Hi-Z microphone to amplifier input (No input XF*)	27 ft	13 ft

Formula: $L = \frac{15{,}000{,}000}{Rp \times C}$

*XF=transformer

where C is capacity of cable in mmf per foot and Rp is parallel combination of actual impedances looking both ways from the cable.

Note 1: For 1 db loss at 10kc and 3 db loss at 20kc, reduce above cable lengths to half.

Note 2: For 2/c cables with one side grounded, use cable mfr's rated capacity for "one conductor to other conductor tied to shield." For 2/c cables in balanced circuit, use 2/3 this capacity.

ALTEC LANSING
SOUND PRODUCTS DIVISION

Litho in U.S.A. CP-981-IM