75Ω ATTENUATOR DESIGN USING PREFERRED VALUE RESISTORS

1. General

Let Ro = characteristic impedance of pad
Rser = Series arm resistor of pad
Rsh = Shunt arm resistor of pad

We can specify Ro in terms of Rser and Rsh, i.e. Ro = F(Rser, Rsh)
Alternatively we can specify either:-

(a) Rser in terms of Ro and Rsh, i.e. Rser = f(Ro, Rsh)

or (b) Rsh in terms of Ro and Rser, i.e. Rsh = ϕ(Ro, Rser)

If we make Ro = 75Ω and choose Rsh to be a preferred value resistor, we obtain from the equation Rser = f(Ro, Rsh) the appropriate value of Rser. If we now take the nearest preferred value to this as the value we will use for the series arm resistor, we obtain a symmetrical pad which is made up of preferred value resistors but the Ro of which is no longer 75Ω. Ro can be calculated from Ro = F(Rser, Rsh) and does not differ greatly from 75Ω. The insertion loss of the pad between 75Ω impedances and the input impedance of the pad when it is terminated in 75Ω can both be calculated.

A similar procedure can be adopted by starting with preferred values for the series arm and using the equation Rsh = ϕ(Ro, Rser). This has been done for T, Π and bridged-T pads with all the preferred values available in the useful range required in television communications (up to about 20 dB).

Sheets CDS 403/2 to 10 show, for each configuration,

(a) Series arm resistor

(b) Shunt arm resistor

(c) Insertion loss

(d) Input impedance when terminated in 75Ω

2. Method

Having decided on the required attenuator configuration the appropriate Insertion Loss tables are consulted. These may disclose a choice of a number of attenuators of the required loss. If this is so, and the range of available resistors is comprehensive, resistors should be chosen which give the best approximation to 75Ω by reference to the "Z in" column.

If the choice of resistors is restricted then the choice of attenuator is confined to that which can be constructed from the available resistors.

Π-type Pads operating between 75Ω impedances (0.12 dB to 1.17 dB)

Rser	Rsh	Ins Loss (dB)	Zin
1.0	10000	0.12	74.88
1.1	10000	0.13	74.98
1.2	9100	0.14	74.96
1.3	9100	0.15	75.06
1.3	8200	0.15	74.93
1.5	7500	0.17	75.00
1.6	6800	0.19	74.95
1.8	6200	0.21	74.99
2.0	5600	0.23	74.99
2.2	5100	0.26	74.99
2.4	4700	0.28	75.01
2.7	4300	0.31	75.08
3.0	3900	0.34	75.11
3.0	3600	0.35	74.88
3.3	3300	0.39	74.89
3.6	3000	0.43	74.86
3.9	3000	0.44	75.14
4.3	2700	0.49	75.12
4.7	2400	0.54	75.01
5.1	2200	0.59	74.98
5.6	2000	0.65	74.97
6.2	1800	0.72	74.94
6.8	1600	0.80	74.78
7.5	1500	0.87	74.98
8.2	1300	0.98	74.57
9.1	1300	1.03	75.37
9.1	1200	1.07	74.73
10	1100	1.17	74.76

Π-Type Pads .....(Contd.) (1.29 dB to 12.6 dB)

Rser	Rsh	Ins Loss (dB)	Zin
11	1000	1.29	74.73
12	910	1.41	74.62
13	910	1.47	75.47
13	820	1.55	74.31
15	750	1.73	74.88
16	680	1.88	74.41
18	620	2.09	74.68
20	560	2.31	74.66
22	510	2.54	74.60
24	470	2.76	74.60
27	430	3.06	75.01
30	390	3.39	75.03
33	360	3.69	75.21
36	330	4.02	75.03
39	300	4.38	74.44
43	270	4.84	73.87
47	270	5.05	75.96
51	240	5.57	74.55
56	220	6.07	74.19
62	200	6.67	73.64
68	200	6.97	75.99
75	180	7.68	74.79
82	180	8.01	77.12
91	160	8.87	75.25
100	150	9.54	75.00
110	150	9.97	77.42
120	130	11.04	73.20
130	130	11.44	75.05
150	120	12.60	74.75

⊓-Type Pads .....(Contd.) (12.95 dB to 20.40 dB)

Rser	Rsh	Ins Loss (dB)	Zin
160	120	12.95	75.85
180	110	14.11	73.84
200	110	14.73	75.88
220	100	15.91	72.44
240	100	16.46	73.88
270	100	17.22	75.78
300	100	17.93	77.42
330	91	19.22	73.08
360	91	19.83	74.17
390	91	20.40	75.14

T-Type Pads Operating between 75Ω Impedances (0.17 dB to 0.89 dB)

Rser	Rsh	Ins Loss (dB)	Zin
1.0	6200	0.17	76.08
1.0	5600	0.17	75.98
1.0	5100	0.18	75.88
1.0	4700	0.18	75.79
1.0	4300	0.19	75.68
1.0	3800	0.20	75.55
1.0	3600	0.21	75.43
1.0	3300	0.21	75.29
1.0	3000	0.22	75.12
1.0	2700	0.24	74.92
1.1	2700	0.25	75.11
1.2	2400	0.27	75.06
1.3	2200	0.30	75.04
1.5	2000	0.34	75.18
1.5	1800	0.35	74.88
1.6	1800	0.37	75.07
1.8	1600	0.41	75.08
2.0	1500	0.45	75.24
2.2	1300	0.51	75.07
2.4	1200	0.55	75.11
2.7	1100	0.61	75.27
2.7	1000	0.64	74.80
3.0	910	0.71	74.84
3.3	820	0.78	74.78
3.6	750	0.85	74.74
3.9	750	0.89	75.29

T-Type Pads .....(Contd.) (0.98 dB to 9.73 dB)

Rser	Rsh	Ins Loss (dB)	Zin
4.3	680	0.98	75.32
4.7	620	1.07	75.32
5.1	560	1.17	75.18
5.6	510	1.29	75.20
6.2	470	1.41	75.44
6.8	430	1.54	75.53
6.8	390	1.62	74.42
7.5	360	1.77	74.62
8.2	330	1.93	74.65
9.1	300	2.13	74.79
10	270	2.36	74.65
11	240	2.62	74.31
12	220	2.86	74.35
13	200	3.12	74.11
15	180	3.52	75.00
16	160	3.85	74.01
18	150	4.21	75.41
20	130	4.76	74.89
22	120	5.18	75.64
24	110	5.64	76.11
24	100	5.90	73.75
27	91	6.54	75.09
30	82	7.22	76.04
30	75	7.53	73.75
33	68	8.24	74.73
36	62	8.96	75.78
39	56	9.73	76.55

T-Type Pads .....(Contd.)(10.15 dB to 20.15 dB)

Rser	Rsh	Ins Loss (dB)	Zin
39	51	10.15	74.24
43	47	11.00	76.61
43	43	11.44	74.52
47	39	12.40	76.55
47	36	12.84	74.89
47	33	13.32	72.97
51	30	14.33	75.23
51	27	14.96	73.24
56	24	16.28	76.28
56	22	16.84	74.84
56	20	17.46	73.35
62	18	18.87	77.91
62	16	19.69	76.33
62	15	20.15	75.52

BRIDGED-T PADS OPERATING BETWEEN 75Ω IMPEDANCES (0.09-0.57 dB)

Rser	Rsh	Ins Loss (dB)	Zin
1.0	10000	0.09	75.43
1.0	9100	0.09	75.37
1.0	8200	0.10	75.31
1.0	7500	0.10	75.24
1.0	6800	0.11	75.17
1.0	6200	0.11	75.09
1.0	5600	0.12	75.00
1.0	5100	0.12	74.90
1.1	5100	0.13	75.00
1.2	4700	0.14	75.00
1.3	4300	0.15	74.99
1.5	3900	0.17	75.06
1.6	3600	0.18	75.04
1.8	3300	0.20	75.09
1.8	3000	0.21	74.93
2.0	2700	0.23	74.92
2.2	2700	0.24	75.11
2.4	2400	0.27	75.05
2.7	2200	0.30	75.13
2.7	2000	0.31	74.90
3.0	1800	0.35	74.88
3.3	1800	0.36	75.16
3.6	1600	0.40	75.08
3.9	1500	0.43	75.14
4.3	1300	0.49	74.98
4.7	1200	0.53	75.01
5.1	1100	0.57	74.99

Bridged-T Pads .....(Contd.) (0.63 dB to 5.23 dB)

Rser	Rsh	Ins Loss (dB)	Zin
5.6	1000	0.63	74.98
6.2	910	0.69	75.02
6.8	820	0.76	74.95
7.5	750	0.83	75.00
8.2	680	0.91	74.94
9.1	620	0.99	75.02
10	560	1.09	74.97
11	510	1.19	74.98
12	470	1.29	75.02
13	430	1.39	74.94
15	390	1.56	75.40
16	360	1.66	75.26
18	330	1.82	75.63
18	300	1.90	74.52
20	270	2.09	74.49
22	270	2.18	75.71
24	240	2.39	75.33
27	220	2.61	75.79
27	200	2.72	74.40
30	180	2.97	74.37
33	180	3.10	75.86
36	160	3.37	75.39
39	150	3.58	75.66
43	130	3.95	74.89
47	120	4.22	75.05
51	110	4.51	74.95
56	100	4.85	74.92
62	91	5.23	75.06

Bridged-T Pads .....(Contd.) (5.62 dB to 20.83 dB)

Rser	Rsh	Ins Loss (dB)	Zin
68	82	5.62	74.84
75	75	6.02	75.00
82	68	6.44	74.84
91	62	6.89	75.06
100	56	7.37	74.92
110	51	7.85	74.95
120	47	8.29	75.05
130	43	8.75	74.89
150	39	9.43	75.66
160	36	9.85	75.39
180	33	10.46	75.86
180	30	10.75	74.37
200	27	11.41	74.40
220	27	11.72	75.79
240	24	12.39	75.33
270	22	12.07	75.71
270	20	13.39	74.49
300	18	14.12	74.52
330	18	14.45	75.63
360	16	15.18	75.26
390	15	15.70	75.40
430	13	16.59	74.94
470	12	17.22	75.02
510	11	17.85	74.98
560	10	18.57	74.97
620	9.1	19.33	75.02
680	8.2	20.09	74.94
750	7.5	20.83	75.00

Table of Resistance obtained by connecting Two Resistors in Parallel

	10	12	15	18	22	27	33	39	47	56	68	82
10	5.0	5.46	6	6.43	6.88	7.30	7.68	7.96	8.24	8.48	8.72	8.91
12	5.46	6.00	6.67	7.20	7.71	8.38	8.80	9.23	9.58	9.88	10.2	10.5
15	6.00	6.67	7.50	8.81	8.92	9.64	10.3	10.8	11.4	11.8	12.3	12.7
18	6.43	7.20	8.18	9.00	9.90	10.8	11.6	12.3	13.0	13.6	14.2	14.8
22	6.88	7.71	8.92	9.90	11.0	12.1	13.2	14.1	16.0	15.8	16.6	17.4
27	7.30	8.38	9.64	10.8	12.1	13.5	14.8	16.0	17.2	18.2	19.3	20.3
33	7.68	8.80	10.3	11.6	13.2	14.8	16.5	17.9	19.4	20.8	22.2	23.5
39	7.96	9.23	10.8	12.3	14.1	16.0	17.9	19.5	21.3	23.0	24.8	26.4
47	8.24	9.58	11.4	13.0	15.0	17.2	19.4	21.3	23.5	25.6	27.8	29.9
56	8.48	9.88	11.8	13.6	15.8	18.2	20.8	23.0	25.6	28.0	30.7	33.3
68	8.72	10.20	12.3	14.2	16.6	19.3	22.2	24.8	27.8	30.7	34.0	37.2
82	8.91	10.47	12.7	14.8	17.4	20.3	23.5	26.4	29.9	33.3	37.2	41.0
100	9.09	10.71	13.0	15.2	18.0	21.3	24.8	28.1	32.0	35.9	40.5	45.0
120	9.23	10.91	13.3	15.6	18.6	22.0	25.9	29.4	34.0	38.2	43.4	48.7
150	9.38	11.11	13.6	16.1	19.2	22.9	27.0	31.0	35.8	40.7	46.8	53.0
180	9.47	11.25	13.8	16.4	19.6	23.5	27.9	32.0	37.3	42.7	49.3	56.3
220	9.57	11.37	14.1	16.6	20.0	24.0	28.7	33.1	38.7	44.6	51.95	59.7
270	9.64	11.49	14.2	16.9	20.3	24.6	29.4	34.1	40.0	46.4	54.3	62.9
330	9.71	11.57	14.35	17.1	20.6	25.0	30.0	34.9	41.1	47.9	56.4	65.7
390	9.75	11.64	14.44	17.26	20.8	25.2	30.4	35.4	41.9	49.0	57.9	67.8
470	9.79	1170	14.53	17.34	21.0	25.5	30.8	36.0	42.7	50.0	59.4	69.8
560	9.82	11.75	14.56	17.44	21.2	25.8	31.2	36.4	43.3	50.9	60.6	71.5
680	9.86	11.79	14.68	17.53	21.3	26.0	31.5	36.9	44.0	51.7	61.8	73.2
820	9.88	11.82	14.73	17.61	21.4	26.1	31.7	37.2	44.4	52.4	62.8	74.5
1000	9.90	11.85	14.78	17.68	21.5	26.3	32.0	37.5	44.9	53.0	63.6	75.8