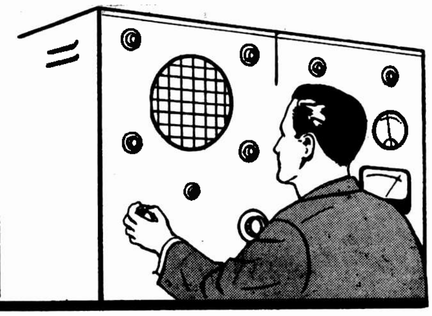
AEROVOX RESEARCH WORKER



The Aerovox Research Worker is edited and published by the Aerovox Corporation to bring to the Radio Experimenter and Engineer, authoritative, first hand information on capacitors and resistors for electrical and electronic application.

VOL. 33 NOS. 4-5-6 APRIL-MAY-JUNE, 1963 Subscription By Application Only

Aids To Timing - Circuit Design

Part 1 RC Circuits

The majority of electronic timing circuits base their operation upon the discharge or discharge rate of a capacitor. This principle is employed in timers, preset alarms, delay circuits, delay relays, metronomes, clocks, light flashers, oscillators, and electronic switches. In the timing circuit, the capacitor charges or discharges through either a resistance or inductance.

This article concerns resistance-capacitance (RC) circuits. The theory of such circuits has been adequately treated in past issues of the *Research Worker.*[1] However, it is important to restate here the following basic facts: (a) In an RC timing circuit, the exponential charge *or* discharge current is $I = (E/R) e^{-t/RC}$ (where I is the instantaneous current in amperes, E the steady-state d-c supply voltage in volts, t the time interval in seconds from the start of charge or discharge, R the resistance in ohms, C the capacitance in farads, and e the base of natural logarithms = 2.71828), and t = RC (where t is the time in seconds required for the charging voltage to rise to 0.6321 maximum or for the discharge voltage to fall to 0.3679 maximum, R the resistance in ohms, and C the capacitance in farads.

Because the time intervals over which most practical RC timing circuits operate are long (milliseconds to hundreds of seconds) by comparison with the millisecond and microsecond intervals encountered in other electronic equipment, R and C, or both, in such circuits is high. Since the high capacitance cannot be varied conveniently, the resistance customarily is made the adjustable element, operated against some readily obtained high capacitance.

[1] See the following articles: "Capacitors in Control Circuits" (August 1942), "Maximum Charge and Discharge Currents for Capacitor, Inductor, and Resistance Circuits" (July-August 1958), and "RC Timing Circuit Considerations" (January-February-March 1962).

Printed by Aerovox Corporation, New Bedford, Mass., U. S. A.

While the calculations for determining required values are simple enough t=RC, R=t/C, C=t/R), they can become a drudge when a number of them must be made. The charts presented in this article are offered in the interest of reducing this labor. Figure 1 is a graph for determining t or R when C=10 microfarads. For other values of capacitance when t is known, multiply the indicated resistance by 10,000/C, where C is the desired capacitance in ufd. For desired values of t and/or R other than those shown on the graph, shift the decimal point in the same direction and by the same amount on resistance and time scales.

For closer determinations, Tables 1 and 2 give resistance values required with seventeen common capacitances from 0.01 to 1000 ufd) and for thirty-eight time rates (from 0.1 to 1000 seconds for both charts). Resistance values are not carried higher than 1000 megohms, since above that figure capacitor leakage resistance and circuit strays might possibly compete with external timing resistance. Similarly, timing rates are not carried higher than 1000 seconds nor lower than 0.1 second, since this range seems most called for in practice. However, R, C, and t values other than those given may be determined by means of interpolation.

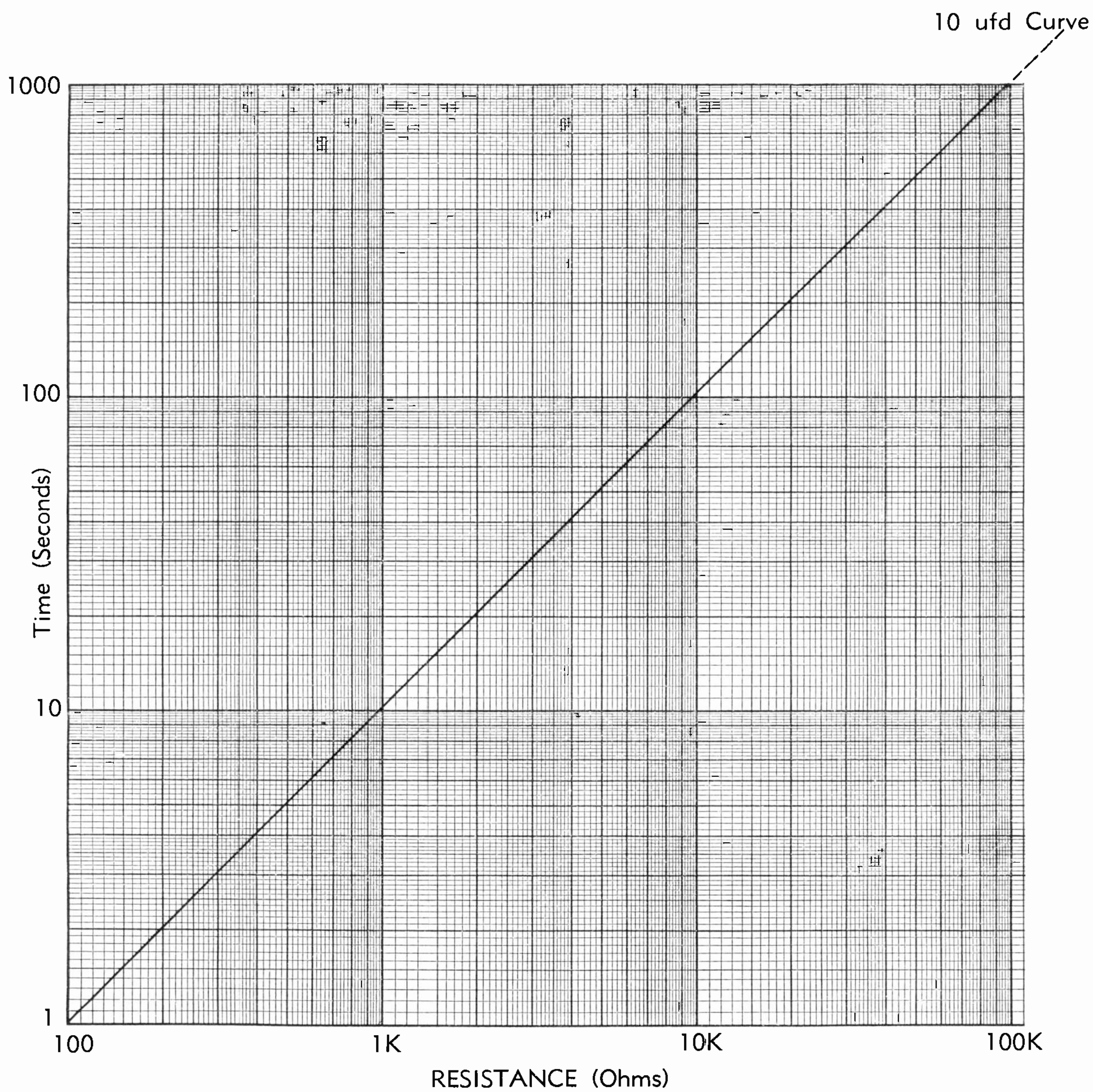


FIGURE 1. RC CIRCUIT CURVE

TIME (t in seconds)	CAPACITANCE (C in Microfarads)															
	0.01	0.02	0.05	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000
0.1	10M	5M	2M	1M	500K	200K	100K	50K	20K	10K	5K	2K	1K	500	200	100
0.2	20M	10M	4M	2M	1M	400K	200K	100K	40K	20K	10K	4K	2K	1K	400	200
0.3	30M	15M	6M	3M	1.5M	600K	300K	150K	60K	30K	15K	6K	3K	1.5K	600	300
0.4	40M	20M	8M	4M	2M	800K	400K	200K	80K	40K	20K	8K	4K	2K	800	400
0.5	50M	25M	10M	5M	2.5M	1M	500K	250K	100K	50K	25K	10K	5K	2.5K	1K	500
0.6	60M	30M	12M	6M	3M	1.2M	600K	300K	120K	60K	30K	12K	6K	3K	1.2K	600
0.7	70M	35M	14M	7M	3.5M	1.4M	700K	350K	140K	70K	35K	14K	7K	3.5K	1.4K	700
0.8	80M	40M	16M	8M	4M	1.6M	800K	400K	160K	80K	40K	16K	8K	4K	1.6K	800
0.9	90M	45M	18M	9M	4.5M	1.8M	900K	450K	180K	90K	45K	18K	9K	4.5K	1.8K	900
1	100M	50M	20M	10M	5M	2M	1M	500K	200K	100K	50K	20K	10K	5K	2K	1K
2		100M	40M	20M	10M	4M	2M	1M	400K	200K	100K	40K	20K	10K	4K	2K
3			60M	30M	15M	6M	3M	1.5M	600K	300K	150K	60K	30K	15K	6K	3K
4			80M	40M	20M	8M	4M	2M	800K	400K	200K	80K	40K	20K	8K	4K
5			100M	50M	25M	10M	5M	2.5M	1M	500K	250K	100K	50K	25K	10K	5K
6				60M	30M	12M	6M	3M	1.2M	600K	300K	120K	60K	30K	12K	6K
7				70M	35M	14M	7M	3.5M	1.4M	700K	350K	140K	70K	35K	14K	7K
8				80M	40M	16M	8M	4M	1.6M	800K	400K	160K	80K	40K	16K	8K
9				90M	45M	18M	9M	4.5M	1.8M	900K	450K	180K	90K	45K	18K	9K
10				100M	50M	20M	10M	5M	2M	1M	500K	200K	100K	50K	20K	10K

TABLE 1. RESISTANCE VALUES

K=kilohms
M=megohms

TIME (t in Seconds)	CAPACITANCE (C in Microfarads)											
	0.2	0.5	1	2	5	10	20	50	100	200	500	1000
10	50M	20M	10M	5M	2M	1M	500K	200K	100K	50K	20K	10K
20	100M	40M	20M	10M	4M	2M	1M	400K	200K	100K	40K	20K
30		60M	30M	15M	6M	3M	1.5M	600K	300K	150K	60K	30K
40		80M	40M	20M	8M	4M	2M	800K	400K	200K	80K	40K
50		100M	50M	25M	10M	5M	2.5M	1M	500K	250K	100K	50K
60			60M	30M	12M	6M	3M	1.2M	600K	300K	120K	60K
70			70M	35M	14M	7M	3.5M	1.4M	700K	350K	140K	70K
80			80M	40M	16M	8M	4M	1.6M	800K	400K	160K	80K
90			90M	45M	18M	9M	4.5M	1.8M	900K	450K	180K	90K
100			100M	50M	20M	10M	5M	2M	1M	500K	200K	100K
200				100M	40M	20M	10M	4M	2M	1M	400K	200K
300					60M	30M	15M	6M	3M	1.5M	600K	300K
400					80M	40M	20M	8M	4M	2M	800K	400K
500					100M	50M	25M	10M	5M	2.5M	1M	500K
600						60M	30M	12M	6M	3M	1.2M	600K
700						70M	35M	14M	7M	3.5M	1.4M	700K
800						80M	40M	16M	8M	4M	1.6M	800K
900						90M	45M	18M	9M	4.5M	1.8M	900K
1000						100M	50M	20M	10M	5M	2M	1M

TABLE 2. RESISTANCE VALUES

K=kilohms
M=megohms

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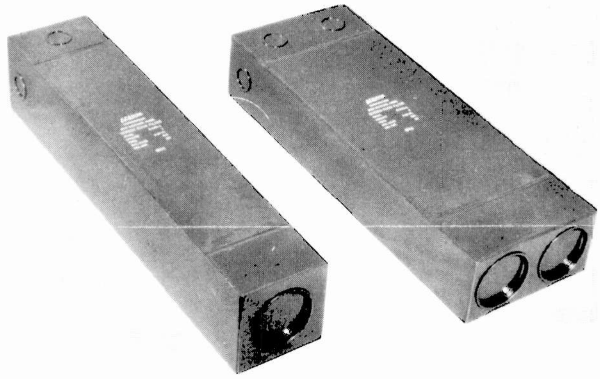
SCREEN ROOM FILTERS



Aerovox Corporation offers a line of screen room filters to comply with rigid specifications set up by designers of the most advanced type screen rooms. All have attenuation equal to or exceeding that of the screen room. Easy mounting arrangements plus high attenuation assure you of the finest equipment specially designed for screen room use. These filters are hermetically sealed and terminals at both ends are shielded. All units are carefully tested before shipment for voltage breakdown, insertion loss, insulation resistance, hermetic sealing and conformance to the physical specifications.

These Aerovox Screen Room filters are used in high quality shielded rooms, interference–free laboratories and in high level RF Induction Heating Equipment where maximum attenuation is required. These Filters are sealed in such a manner to meet most existing military requirements as well as designed to give exceedingly long life and maximum efficiency in all applications where quality is foremost.

All internal components are carefully designed and engineered to provide high attenuation, minimum voltage drop, and trouble free performance for continuous operation.

Part No.	Current (Amps)	Voltage Rating	CPS	Circuits	Minimum Attenuation vs. Frequency Measured in a 50 Ohm System Per Mil-Std-220	Size in Inches		
						Length	Width	Depth
S-1076-1	50	250 VAC/VDC	0-60	1	100 db from 14KC to 1000 MC	20	3 5/8	3 5/8
S-1076-2	50	250 VAC/VDC	0-60	2	100 db from 14KC to 1000 MC	20	7 3/16	3 5/8
S-1076-3	50	250 VAC/VDC	0-60	3	100 db from 14KC to 1000 MC	20 1/8	10 7/8	3 11/16
S-1142-1	30	500 VAC/VDC	0-400	1	100 db from 150KC to 1000 MC	10 1/8	2 7/8	2 7/16
S-1142-2	30	500 VAC/VDC	0-400	2	100 db from 150KC to 1000 MC	10 1/8	4 3/4	2 7/16
S-1142-3	30	500 VAC/VDC	0-400	3	100 db from 150KC to 1000 MC	10 1/8	7	2 7/16
S-1304-1	80	250 VAC/VDC	0-60	1	100 db from 14KC to 1000 MC	22	4 3/8	4 3/8
S-1305-1	100	500 VAC/VDC	0-1000	1	100 db from 100KC to 1000 MC	22	4 3/8	4 3/8
S-1302-1	100	500 VAC/VDC	0-60	1	100 db from 200KC to 1000 MC	14	4 3/8	4 3/8
S-1303-1	60	500 VAC/VDC	0-1000	1	100 db from 100KC to 1000 MC	20	3 5/8	3 5/8
S-1361-1	100	500 VAC/VDC	0-60	1	100 db from 14KC to 1000 MC	22	4 3/8	4 3/8
S-1432-1	100	500 VAC/VDC	0-60	1	100 db from 100KC to 1000 MC	22	4 3/8	4 3/8
S-1455-1	100	500 VAC/VDC	0-60	1	100 db from 150KC to 1000 MC	22	4 3/8	4 3/8
*S-1468-A	50	500 VAC/VDC	0-1000	1	60 db from 1000MC to 10,000MC	10 3/4	DIAMETER 7/8"	
*S-1468-B	100	500 VAC/VDC	0-1000	1	60 db from 1000MC to 10,000MC	10 3/4	7/8"	

* When used in conjunction with a standard screen room filter, the attenuation will be greater than 100 db from 1000 to 20,000 megacycles.

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