Programable calculator analyzes filter designs

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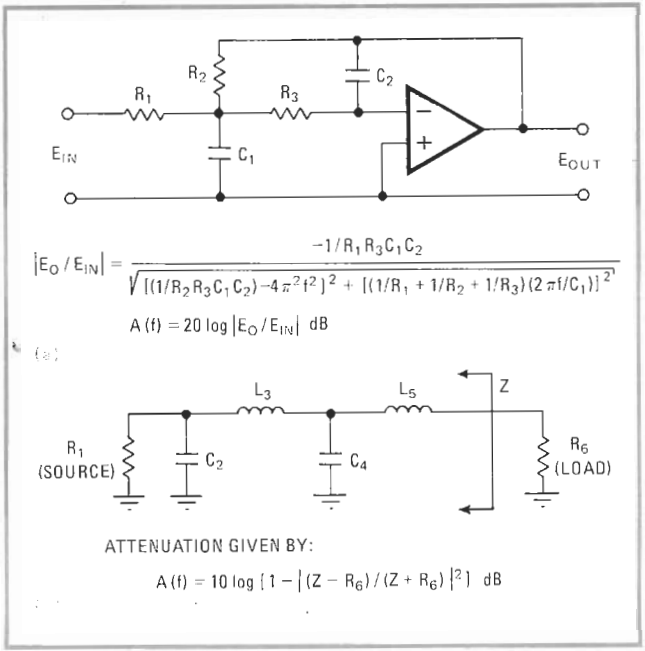
An SR-56 calculator can provide a quick check on low-pass circuits laid out with the excellent filter-design programs in its applications library or on any other active or passive low-pass filter with up to four components. The calculator can be programed to analyze the performance of these filter circuits, giving the gain or

Circuits analyzed. The frequency responses of the active low-pass filter in a and the passive low-pass filter in b are quickly plotted by use of the programs given for the SR-56 calculator. The decibel value of A(f) is displayed at a chosen initial frequency f_i and at successive incremented frequencies ($f_i + \Delta f$), ($f_i + 2\Delta f$) . . . as the R/S key is pushed repeatedly.



attenuation at an incremental frequency each time the R/S key is pushed.

The theory of operation for the active-filter analysis is straightforward. It simply solves the gain-versus-frequency equations that are shown along with the circuit diagram in part a of the figure. The program (Table 1) includes provision for entering a starting frequency, f_1, and a frequency step size, Δf. Then simply pressing R/S repeatedly produces the data for plotting a linear frequency-response graph.

The passive-filter analysis works by calculating, at each frequency, the complex impedance that is seen looking back into the filter network from the load, as illustrated in part b of the figure. This filter impedance and the load resistance are then used in the equation given below to calculate the attenuation through the circuit.

The passive-filter program (Table 2) also provides for rapid plotting of frequency response curves, using f_1 and Δf. For filters with fewer than four reactive elements, zeroes should be inserted in place of the unused element values. The run time for this program is about 8 seconds for each frequency. □

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

TABLE 1: SR-56 PROGRAM FOR ANALYSIS OF ACTIVE LOW-PASS FILTER

LOC	KEY	LOC	KEY	LOC	KEY
00	STO	30	RCL	60	X
01	7	31	0	61	RCL
02	RCL	32	1/x	62	6
03	2	33	+	63	+/−
04	X	34	RCL	64	÷
05	RCL	35	1	65	RCL
06	3	36	1/x	66	0
07	X	37	+	67	=
08	RCL	38	RCL	68	|x|
09	4	39	2	69	LOG
10	=	40	1/x	70	X
11	1/x	41	=	71	2
12	STO	42	÷	72	0
13	6	43	RCL	73	=
14	÷	44	3	74	STO
15	RCL	45	X	75	8
16	1	46	2	76	RCL
17	−	47	X	77	5
18	RCL	48	π	78	SUM
19	7	49	X	79	7
20	x^2	50	RCL	80	RCL
21	X	51	7	81	8
22	4	52	=	82	R/S
23	X	53	x^2	83	GTO
24	π	54	+	84	0
25	x^2	55	RCL	85	2
26	=	56	9		
27	x^2	57	=		
28	STO	58	$\sqrt{x}$		
29	9	59	1/x		

REGISTERS	
0	R_1
1	R_2
2	R_3
3	C_1
4	C_2
5	Δf
6	temporary
7	temporary
8	temporary
9	temporary

STEP	PROCEDURE	ENTER	PRESS			DISPLAY
			CLR	CMS	RST	
1	enter program, initialize					
2	enter data	R_1	STO	0		
		R_2	STO	1		
		R_3	STO	2		
		C_1	STO	3		
		C_2	STO	4		
		Δf	STO	5		
3	enter initial frequency	f_1	R/S			A (f_1)
4	continue		R/S			A (f_1 + Δf)
						A (f_1 + 2Δf)

Note: For single frequency analysis, enter the frequency and press RST, then R/S.

TABLE 2: SR-56 PROGRAM FOR ANALYSIS OF PASSIVE LOW-PASS FILTER

LOC	KEY	LOC	KEY	LOC	KEY	LOC	KEY
00	X	30	7	60	=	90	PROD
01	π	31	5	61	LOG	91	9
02	X	32	SUBR	62	X	92	RTN
03	2	33	8	63	1	93	x^2
04	=	34	1	64	0	94	+
05	SUM	35	RCL	65	=	95	RCL
06	0	36	6	66	R/S	96	9
07	RCL	37	INV	67	CLR	97	x^2
08	1	38	SUM	68	STO	98	=
09	1/x	39	8	69	8	99	RTN
10	SUM	40	X	70	STO		
11	8	41	2	71	9		
12	RCL	42	+	72	RCL		
13	2	43	RCL	73	7		
14	SUBR	44	8	74	RST		
15	7	45	=	75	X		
16	5	46	SUBR	76	RCL		
17	RCL	47	9	77	0		
18	3	48	3	78	=		
19	SUBR	49	1/x	79	SUM		
20	7	50	X	80	9		
21	5	51	(	81	RCL		
22	RCL	52	RCL	82	8		
23	4	53	8	83	SUBR		
24	SUBR	54	SUBR	84	9		
25	7	55	9	85	3		
26	5	56	3	86	1/x		
27	RCL	57	+/−	87	PROD		
28	5	58	+	88	8		
29	SUBR	59	1	89	+/−		

REGISTERS	
0	2 π f
1	R_1
2	C_2
3	L_3
4	C_4
5	L_5
6	R_6
7	Δf
8	temporary
9	temporary

STEP	PROCEDURE	ENTER	PRESS			DISPLAY
			CLR	CMS	RST	
1	enter program, initialize					
2	enter data	R_1	STO	1		
		C_2	STO	2		
		L_3	STO	3		
		C_4	STO	4		
		L_5	STO	5		
		R_6	STO	6		
		Δf	STO	7		
3	enter initial frequency	f_1	R/S			A (f_1)
4	continue		R/S			A (f_1 + Δf)
			R/S			A (f_1 + 2Δf)
			↓			↓

Note: For single frequency analysis, press CLR, STO 0, STO 8, STO 9; enter the frequency, press RST, R/S.