



T-64-05

FREQUENCY DEVICES INC

FEATURES

- Cutoff Frequencies (f_c) from 0.1Hz to 50kHz
- Large Tuning Ratio - to 500:1
- High Performance:
 - Input Impedance - $10^9 \Omega$
 - Stability of f_c - 0.05%/°C
 - Output Noise Voltage - 75 μ V RMS
 - Output Impedance - 1Ω

APPLICATIONS

- Anti- Aliasing
- Vibration Studies
- Noise Reduction
- Band Isolation

DESCRIPTION

Frequency Devices, Inc. offers this family of resistive tuneable two, four, and six-pole lowpass active filters in both Butterworth and Bessel configurations. The pass band of each device extends from dc, where a non-inverting gain is held within 0.02dB of unity, to the selected cutoff frequency, f_c . The dc offset voltage may be externally adjusted to zero. Offset drift is less than 30 μ V/°C for the two and four-pole devices and less than 75 V/°C for the six-pole devices. The cutoff frequency adjustment range of any particular unit is 200:1 or 500:1. Table 1 below defines this range for each filter.

BUTTERWORTH			BESSEL			TUNING RANGE (Hz)	
2-Pole	4-Pole	6-Pole	2-Pole	4-Pole	6-Pole	f_{cmin}	f_{cmax}
738BT-1	730BT-1	736BT-1	738LT-1	730LT-1	736LT-1	0.1	20
738BT-2	730BT-2	736BT-2	738LT-2	730LT-2	736LT-2	1	200
738BT-3	730BT-3	736BT-3	738LT-3	730LT-3	736LT-3	10	2K
738BT-4	730BT-4	736BT-4	738LT-4	730LT-4	736LT-4	100	20K
748BT-1	740BT-1	746BT-1	748LT-1	740LT-1	746LT-1	0.5	50
748BT-2	740BT-2	746BT-2	748LT-2	740LT-2	746LT-2	1	500
748BT-3	740BT-3	746BT-3	748LT-3	740LT-3	746LT-3	10	5K
748BT-4	740BT-4	746BT-4	748LT-4	740LT-4	746LT-4	100	50K

TABLE 1: Cutoff Frequency Adjustment Range from f_{cmin} to f_{cmax}



FREQUENCY DEVICES INC

(Typical @ 25°C and $\pm V_S = 15V$ unless otherwise noted)

ACTIVE CHARACTERISTICS	TWO-POLE 738/748	FOUR-POLE 730/740	SIX-POLE 736/746
Tolerance of f_c ¹	±3%	±3%	±3%
Stability of f_c	±0.05% / °C ¹ -- 2	±0.05% / °C ¹	±0.05% / °C ¹ -- 2
Input			
Impedance	10 ⁹ Ω	10 ⁹ Ω	10 ⁹ Ω
Voltage Range	±10V	±10V	±10V
Bias Current	10nA	10nA	10nA
Output ³			
Rate Output @ 2mA	±10V	±10V	±10V
Noise ⁴	75μV RMS	75μV RMS	75μV RMS
Resistance	1Ω	1Ω	1Ω
Offset Voltage ⁵	±5mV	±5mV	±5mV
Offset Drift	±30μV / °C	±50μV / °C	±75μV / °C
dc Gain (non-inverting)	0 ± 0.02dB	0 ± 0.02dB	0 ± 0.02dB
TEMPERATURE			
Operating	0 to +70°C	0 to +70°C	0 to +70°C
Storage	-25 to +85°C	-25 to +85°C	-25 to +85°C
POWER SUPPLY(DC)			
Rated Voltage	±15V	±15V	±15V
Operating	±12 to ±18V	±12 to ±18V	±12 to ±18V
Quiescent Current	8mA (738) 16mA (748)	12mA (730) 22mA (740)	16mA (736) 28mA (746)

NOTES:

- 1) Applicable when using matched 1%, 100ppm/°C resistors.
- 2) Frequency drifts of 0.01% / °C available on request.
- 3) Output short circuit protected to ground.
- 4) Noise, dc to 50kHz, excluding dc offset, input grounded.
- 5) Adjustable to zero using 1kΩ trim pot. F.D.I. P/N 79PR1K.



FREQUENCY DEVICES INC

APPLYING THE TUNEABLE FILTER

These filters may be used in data transmission, test instrumentation and frequency analysis applications where signal fidelity and adjustable cutoff frequency are critical requirements. Being adjustable at the time of system assembly, they perform equally well when utilized in fixed cutoff frequency applications.

The corner frequency is tuned with the 1% resistor value closest to the theoretical value obtained with Eq. 1. The tuning resistors should be connected as indicated in Figure 1. The number of tuning resistors required is equal to the number of filter poles.

Optional potentiometer P may be used to trim the output offset. It should be adjusted with the filter input grounded. See Figure 3.

The filter input is a high impedance buffer ($10^9 \Omega$) which requires 10nA bias current. Therefore, the filter cannot be capacitor coupled without provision for biasing. If it is necessary to ac couple the filter, the circuit in Figure 2 is recommended. The biasing provision acts as a single pole highpass filter section with a time constant determined by R & C. Values of R up to 1 Meg may be used without degrading the offset specification.

$$R(K\Omega) = R_o \left[\frac{f_c(\max)}{f_c} \cdot 1 \right] \quad \begin{array}{l} R_o = 5 (730, 736, 738) \\ R_o = 2 (740, 746, 748) \end{array}$$

Equation 1

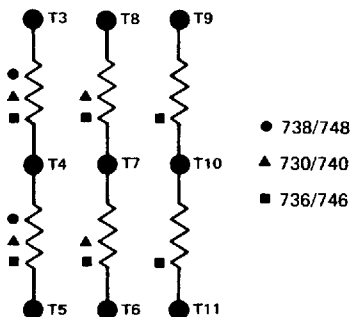


Figure 1: Frequency Tuning

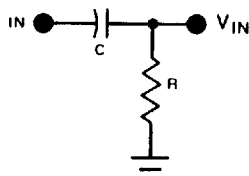
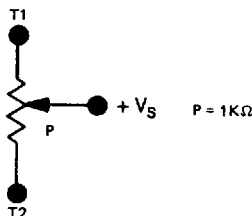
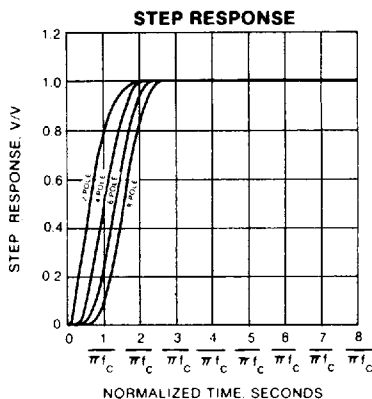
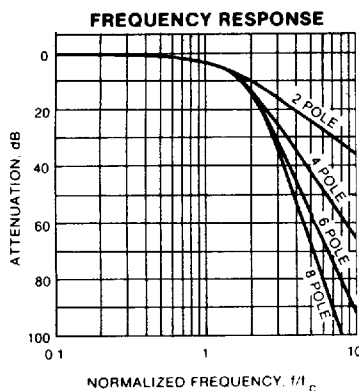
Figure 2: Biasing for
Capacitor Coupling

Figure 3: Offset Adjustment

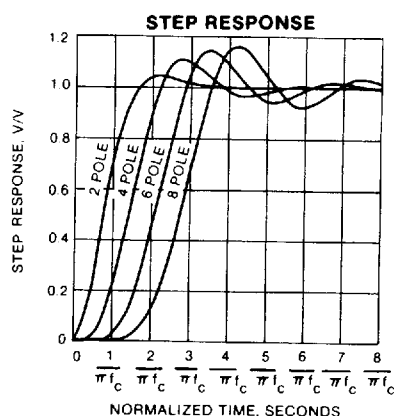
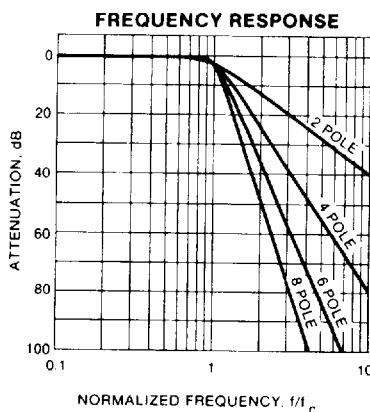

**FREQUENCY
DEVICES™**
**730/740 SERIES
THEORETICAL RESPONSE
BESSEL**
FREQUENCY DEVICES INC

NORMALIZED FREQUENCY RESPONSE TABLE

f/f_c	2 POLE		4 POLE		6 POLE		8 POLE	
	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$
0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
0.10	0.03	-7.8	0.03	-12.1	0.03	-15.5	0.03	-18.2
0.20	0.11	-15.6	0.11	-24.2	0.12	-31.0	0.12	-36.4
0.30	0.25	-23.4	0.25	-36.3	0.26	-46.5	0.26	-54.7
0.40	0.45	-31.2	0.45	-48.4	0.46	-62.0	0.47	-72.9
0.50	0.71	-38.3	0.71	-60.6	0.73	-77.4	0.74	-91.1
0.60	1.04	-46.4	1.02	-72.7	1.05	-92.9	1.06	-109.3
0.65	1.24	-50.1	1.21	-78.7	1.24	-100.7	1.25	-118.4
0.70	1.44	-53.8	1.41	-84.8	1.44	-108.4	1.45	-127.5
0.75	1.67	-57.4	1.63	-90.8	1.66	-116.2	1.67	-136.6
0.80	1.91	-61.0	1.86	-96.8	1.89	-123.9	1.91	-145.7
0.85	2.16	-64.4	2.12	-102.9	2.15	-131.7	2.16	-154.9
0.90	2.43	-67.8	2.40	-108.9	2.42	-139.4	2.42	-164.0
0.95	2.72	-71.1	2.69	-114.9	2.70	-147.1	2.71	-173.1
1.00	3.01	-74.3	3.01	-120.8	3.01	-154.9	3.01	-182.2
1.10	3.63	-80.4	3.71	-132.6	3.68	-170.4	3.67	-200.4
1.20	4.28	-86.1	4.51	-144.2	4.44	-185.8	4.40	-218.6
1.30	4.96	-91.4	5.39	-155.5	5.29	-201.2	5.20	-236.8
1.40	5.66	-96.3	6.37	-166.4	6.23	-216.5	6.10	-255.0
1.50	6.36	-100.8	7.42	-176.7	7.29	-231.5	7.08	-273.2
2.00	9.82	-118.4	13.41	-219.4	14.17	-300.2	13.68	-361.9
2.50	12.96	-130.1	19.43	-247.8	22.54	-350.7	23.08	-436.4
3.00	15.74	-138.2	25.09	-267.3	30.70	-384.7	33.38	-489.2
3.50	18.19	-144.0	30.04	-281.0	38.08	-408.4	42.85	-525.4
4.00	20.36	-148.5	34.43	-291.2	44.68	-425.8	51.81	-551.8
5.00	24.07	-154.8	41.92	-305.2	55.93	-449.5	66.80	-587.3
6.00	27.15	-159.0	48.12	-314.5	65.25	-465.0	79.22	-610.2
7.00	29.77	-162.0	53.40	-321.1	73.17	-475.9	89.80	-626.3
8.00	32.06	-164.2	57.99	-326.0	80.07	-484.0	98.99	-638.2
9.00	34.08	-166.0	62.05	-329.8	86.16	-490.3	107.12	-647.4
10.00	35.89	-167.4	65.68	-332.8	91.62	-495.3	114.40	-654.8

NOTE: Eight pole not available in Resistive Tuneable configuration at this time. See Fixed Frequency Lowpass Filter data section.


**FREQUENCY
DEVICES™**
**730/740 SERIES
THEORETICAL RESPONSE
BUTTERWORTH**

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FREQUENCY DEVICES INC

NORMALIZED FREQUENCY RESPONSE TABLE

$1/f_c$	2 POLE		4 POLE		6 POLE		8 POLE	
	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$	A(dB)	$\psi(^{\circ})$
0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
0.10	0.00	-8.1	0.00	-15.0	0.00	-22.0	0.00	-29.4
0.20	0.01	-16.4	0.00	-30.1	0.00	-44.5	0.00	-59.0
0.30	0.04	-25.0	0.00	-45.5	0.00	-67.2	0.00	-89.1
0.40	0.11	-34.0	0.00	-61.4	0.00	-90.4	0.00	-119.8
0.50	0.26	-43.3	0.02	-78.0	0.00	-114.5	0.00	-151.7
0.60	0.53	-53.0	0.07	-95.7	0.01	-140.0	0.00	-185.0
0.65	0.71	-57.9	0.14	-105.1	0.02	-153.4	0.00	-202.6
0.70	0.93	-62.7	0.24	-114.9	0.06	-167.5	0.01	-220.9
0.75	1.19	-67.6	0.41	-125.2	0.14	-182.4	0.04	-240.2
0.80	1.49	-72.3	0.67	-135.9	0.29	-198.2	0.12	-260.8
0.85	1.82	-77.0	1.05	-146.9	0.58	-215.2	0.31	-283.2
0.90	2.19	-81.5	1.55	-158.1	1.08	-233.1	0.74	-307.4
0.95	2.59	-85.8	2.21	-169.2	1.88	-251.6	1.59	-333.5
1.00	3.01	-90.0	3.01	-180.0	3.01	-270.0	3.01	-360.0
1.10	3.92	-97.7	4.97	-199.9	6.17	-303.6	7.48	-407.9
1.20	4.88	-104.5	7.24	-216.8	9.96	-330.6	12.90	-444.5
1.30	5.86	-110.6	9.62	-230.8	13.86	-351.7	18.30	-472.1
1.40	6.85	-115.9	11.98	-242.2	17.61	-368.4	23.40	-493.7
1.50	7.83	-120.5	14.25	-251.7	21.16	-382.0	28.18	-511.4
2.00	12.30	-136.7	24.10	-282.0	36.12	-425.5	48.16	-568.3
2.50	16.03	-146.0	31.84	-298.6	47.75	-449.6	63.67	-600.2
3.00	19.14	-152.1	38.17	-309.3	57.25	-465.2	76.34	-620.8
3.50	21.79	-156.3	43.53	-316.7	65.29	-476.1	87.05	-635.3
4.00	24.10	-159.3	48.16	-322.2	72.25	-484.2	96.33	-646.0
5.00	27.97	-163.6	55.92	-329.9	83.88	-495.5	111.84	-661.0
6.00	31.13	-166.4	62.25	-334.9	93.38	-503.0	124.50	-670.9
7.00	33.81	-168.3	67.61	-338.6	101.41	-508.3	135.22	-677.9
8.00	36.12	-169.8	72.25	-341.2	108.37	-512.3	144.49	-683.2
9.00	38.17	-171.0	76.34	-343.3	114.51	-515.4	152.68	-687.3
10.00	40.00	-171.9	80.00	-345.0	120.00	-517.8	160.00	-690.6

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Frequency 25 Haverhill,
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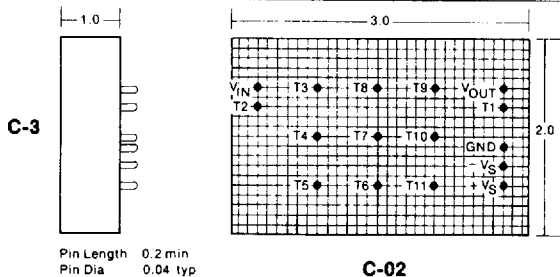
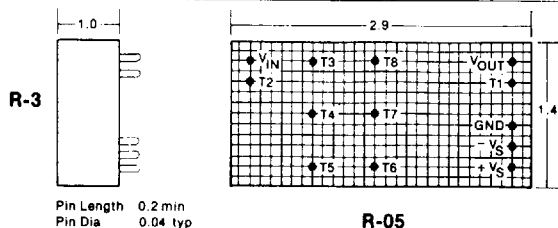
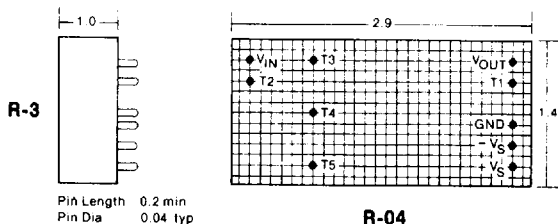
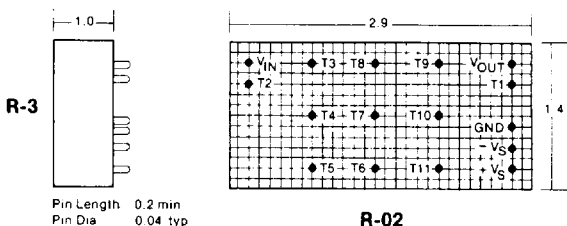
**FREQUENCY
DEVICES****FREQUENCY DEVICES INC**

MODEL NUMBERS		CASE STYLE	CONNEC- TION
BUTTERWORTH	BESSEL		
730BT-1	730LT-1	R-3	R-05
730BT-2	730LT-2	R-3	R-05
730BT-3	730LT-3	R-3	R-05
730BT-4	730LT-4	R-3	R-05
740BT-1	740LT-1	R-3	R-05
740BT-2	740LT-2	R-3	R-05
740BT-3	740LT-3	R-3	R-05
740BT-4	740LT-4	R-3	R-05
736BT-1	736LT-1	C-3	C-02
736BT-2	736LT-2	R-3	R-02
736BT-3	736LT-3	R-3	R-02
736BT-4	736LT-4	R-3	R-02
746BT-1	746LT-1	C-3	C-02
746BT-2	746LT-2	R-3	R-02
746BT-3	746LT-3	R-3	R-02
746BT-4	746LT-4	R-3	R-02
738BT-1	738LT-1	R-3	R-04
738BT-2	738LT-2	R-3	R-04
738BT-3	738LT-3	R-3	R-04
738BT-4	738LT-4	R-3	R-04
748BT-1	748LT-1	R-3	R-04
748BT-2	748LT-2	R-3	R-04
748BT-3	748LT-3	R-3	R-04
748BT-4	748LT-4	R-3	R-04

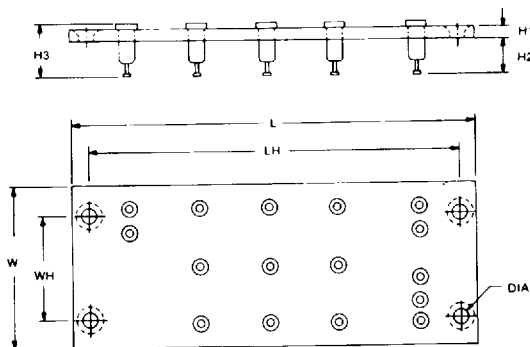
Mechanical drawings for each case style are detailed farther on.


**FREQUENCY
DEVICES™**
**730/740 SERIES
PACKAGING DATA**

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FREQUENCY DEVICES INC

**BOTTOM
VIEWS**
TERMINAL KEY

V_{IN}	Input Signal
V_{OUT}	Output Signal
GND	Reference for Input, Output & Supply
T1, T2	Contact Points for Offset Trim
T3 thru T11	Tuning Resistor Contacts
$+V_S$	Supply Voltage, Positive
$-V_S$	Supply Voltage, Negative

FREQUENCY DEVICES INC
SOCKET S1002

DIMENSION	MILLIMETERS	INCHES
L	89	3.5
LH	81	3.2
W	36	1.4
WH	23	0.9
H1	2.3	0.09
H2	7.9	0.31
H3	12	0.47
DIA	3.5	0.14

ACCESSORIES

Socket Part Number	S1002
Offset Trim Pot P1	79PR1K
Power Supply	See the F.D.I. 100 Series data

HOW TO ORDER

Any one of the 48 models in this series may be ordered by specifying the part number of the unit you desire. This number is unique and it describes a part having the parameters defined by this data sheet.